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CHECKLIST

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# Checklist of ascidians (Chordata, Tunicata) from the southern Gulf of Mexico

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## Abstract

This study is the first inventory of ascidians from shallow waters (0–25 m) of coastal and reef habitats in the southern Gulf of Mexico where ascidian diversity is poorly known. Sampled environments in 14 locations (38 sites) with 134 samples collected from 2015 to 2017 included coral reefs, coastal lagoons, mangroves, seagrass, ports, and artificial platforms. The 31 identified species comprise 19 genera and 13 families. Ten species are newly reported in the Gulf of Mexico: *Ascidia panamensis* Bonnet & Rocha, 2011; *Ecteinascidia styeloides* (Traustedt, 1882); *Cystodytes roseolus* Hartmeyer, 1912; *Eudistoma* aff. *amanitum* Paiva & Rocha, 2018; *Eudistoma recifense* Millar, 1977; *Euherdmania fasciculata* Monniot, 1983; *Euherdmania* aff. *vitrea* Millar, 1961; *Polycarpa cartilaginea* (Sluiter, 1885); *Botrylloides magnicoecum* (Hartmeyer, 1912) and *Didemnum granulatum* Tokioka, 1954. Two new species will be described separately (*Clavelina* sp. and *Pyura* sp.). This study provides the first records for 26 species ascidians for the region as well as describes increased distributions of ten Atlantic species. Thus, our data provide a starting point for future ecological, experimental and taxonomic studies of ascidians of the Gulf of Mexico.

## Keywords

Ascidiacea, biodiversity, Gulf of Mexico, Yucatán

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## Introduction

The Ascidiacea is the most diverse class of tunicates with ca 3000 recognized species, with representatives found in all marine habitats (Shenkar and Swalla 2011). Local ascidian species diversity depends primarily on availability and diversity of hard substrates, as well as temperature and salinity (Lambert 2005), while population density depends on food availability (organic particles suspended in water; Monniot et al. 1991). Ascidians are active suspension filter-feeders and are key organisms at times when they contribute to the control of phytoplankton (Petersen and Riisgard 1992) and may reduce eutrophication or contaminant concentration (Naranjo et al. 1996, Draughon et al. 2010). Many species colonize most artificial substrates and thereby become among the dominant members of "fouling" communities (Carballo 2000). Among foulers there are species known for their invasion potential worldwide (Lambert 2005). Ascidians are also known because of the presence of bioactive metabolites with potential biomedical interest (Erba et al. 2001).

Ascidian diversity in the Gulf of Mexico includes records of 79 species in 15 families in the northern Gulf of Mexico (Carballo 2000, Cole and Lambert 2009, CONABIO 2016, Fortaleza and Lotufo 2018). The southern Gulf of Mexico, however, is much less known and, despite the ecological and biotechnological importance of ascidians, only includes nine reported species: *Aplidium exile* (Van Name, 1902); *Polyclinum constellatum* Savigny, 1816; *Ecteinascidia turbinata* Herdman, 1880; *Eudistoma capsulatum* (Van Name, 1902); *Eudistoma hepaticum* (Van Name, 1921); *Stomozoa roseola* (Millar, 1955); *Botrylloides niger* Herdman, 1886; *Symplegma brakenhielmi* (Michaelsen, 1904) and *Symplegma viride* Herdman, 1886 (Van Name 1945; Carballo 2000). Essentially there are no studies from Mexico and the seven reported species is far below the expected number considering the great diversity of suitable habitats. To fill this gap, here we provide an inventory of the coastal species of ascidians in reefs and other shallow habitats in the southern Gulf of Mexico, along the Yucatán Peninsula.

## Material and methods

Samples were collected in 14 locations and 38 sites from 2015 to 2017 in coral reefs, coastal lagoons, mangroves, seagrass, ports and artificial platforms by free diving and SCUBA, in the states of Veracruz, Tabasco, Campeche, Yucatan and Quintana Roo (Fig. 1, Table 2). Specimens were anesthetized in menthol and fixed with 4% formaldehyde in seawater. External characters of ascidians provide little information for determining their taxonomy and therefore dissection is required, for which a list of multiple characters is available (Monniot and Monniot 1972; Monniot et al. 1991; Rocha et al. 2012). Dissection was carried out following Monniot and Monniot (1972) and internal structures were stained with Harris hematoxylin dye (see: https://bocasarts.weebly.com/tunicate-tools.html). Families and genera were identified following Rocha et al. (2012) for species of the Atlantic Ocean.

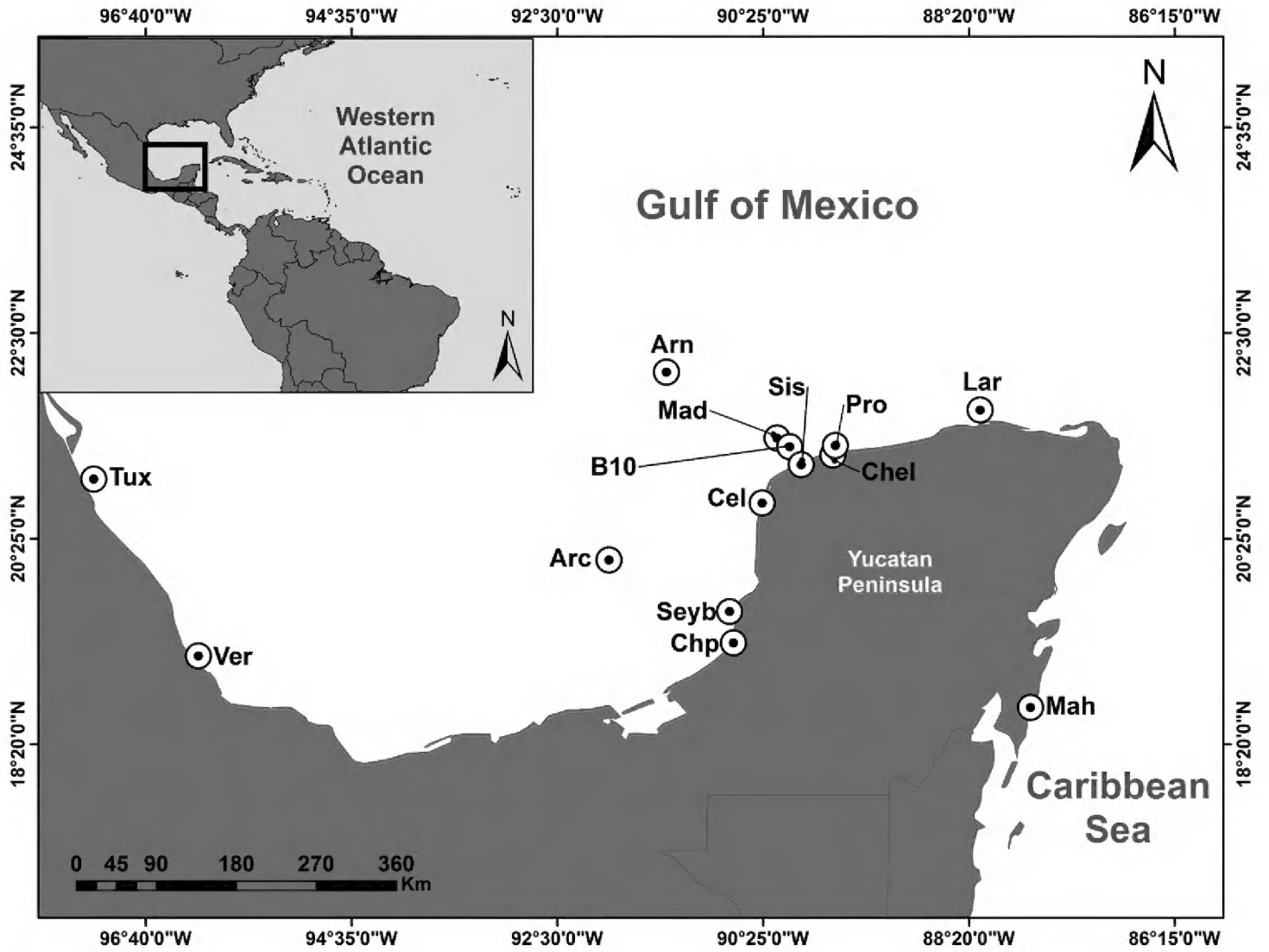


**Figure 1.** Study area in the southern Gulf of México. Abbreviations: Tuxpan Reef – Tux, Veracruz Reef– VeR, Arcas Cay Reef – Arc, Seybaplaya – Sey, Champotón – Chp, Celestún – Cel, Arenas Cays – Arn, Madagascar Reef – Mad, Bajo 10 Reef– B10, Chelém Coastal Lagoon – Chel, Progreso Harbor – Pro, Ría Lagartos – Lag, Mahahual Harbor – Mah, and Sisal Harbor – Sis.

Specimens were deposited in the Colección de Ascidias del Golfo de México (CAGoM), which is part of the collection of the Marine Invertebrates of Gulf of Mexico, National Autonomous University of Mexico (UNAM), Mérida, Yucatán. The resulting dataset has been uploaded to the Zenodo data repository (Alvarez et al. 2018).

## Results

In 134 samples we identified 31 species in 19 genera and 13 families in 14 locations at 38 sites (see Table 2). We report ten species for the first time in the Gulf of Mexico: *Ascidia panamensis* Bonnet & Rocha, 2011; *Cystodytes roseolus* Hartmeyer, 1912; *Ecteinascidia styeloides* (Traustedt, 1882); *Eudistoma* aff. *amanitum* Paiva & Rocha, 2018; *Eudistoma recifense* Millar, 1977; *Euherdmania fasciculata* Monniot, 1983; *Euherdmania* aff. *vitrea* Millar, 1961; *Polycarpa cartilaginea* (Sluiter, 1885); *Botrylloides magnicoecus* (Hartmeyer, 1912) and *Didemnum granulatum* Tokioka, 1954 (Table 1) and two new species that will be reported somewhere else. Most specimens were found on natural substrates (rocks, corals and algae) followed by artificial substrates (oil platforms, docks and sunken ships).

**Table 1.** Species checklist of ascidians in south Gulf of Mexico. Abbreviations: (Tux) Reef Tuxpan, (VeR) Veracruz Reef, (Arc) Reef Arcas Cay, (Sey) Seybaplaya, (Chp) Champotón, (Cel) Celestún, (Arn) Arenas Cays, (Mad) Reef Madagascar, (B10) Reef Bajo 10, (Chel) Coastal Lagoon Chelém, (Pro) Progreso Harbor, (Lar) Ría Lagartos (Sis) Sisal Harbor, and (Mah) Mahahual Harbor. (*) New records for Gulf of Mexico.

| | Tux | Ver | Arc | Seyb | Chp | Cel | Arn | Mad | B10 | Chel | Pro | Lar | Mah | Sis | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **# spp** | **4** | **2** | **8** | **3** | **2** | **2** | **4** | **15** | **10** | **6** | **12** | **7** | **1** | **2** | **# Sites** |
| **Order Phlebobranchia** | | | | | | | | | | | | | | | |
| **Ascidiidae** | | | | | | | | | | | | | | | |
| *Ascidia panamensis** | | | • | | | | | • | | | | | | | 2 |
| *Phallusia nigra* | • | • | | | • | | | | | • | • | | | | 4 |
| **Corellidae** | | | | | | | | | | | | | | | |
| *Corella minuta* | | | • | | | | | | | | | | | | 1 |
| **Perophoridae** | | | | | | | | | | | | | | | |
| *Ecteinascidia styeloides** | | | • | | | | | | • | • | | • | | | 4 |
| *Ecteinascidia turbinata* | • | | • | | | | • | | | • | • | | | | 4 |
| **Order Aplousobranchia** | | | | | | | | | | | | | | | |
| **Clavelinidae** | | | | | | | | | | | | | | | |
| *Clavelina oblonga* | | | | • | | | | • | | | | | | | 2 |
| *Clavelina* sp. | | | | | | | • | | | | | | | | 1 |
| **Polycitoridae** | | | | | | | | | | | | | | | |
| *Cystodytes dellechiajei* | | | | | | | | | • | | | | | | 1 |
| *Cystodytes roseolus** | | | | | | | | • | • | | • | | | | 3 |
| *Eudistoma* aff. *amanitum** | | | | | | | | • | • | | | • | | | 3 |
| *Eudistoma clarum* | | | | | | | | • | | | • | • | | | 3 |
| *Eudistoma hepaticum* | | | | • | | • | | • | • | | • | | | | 5 |
| *Eudistoma obscuratum* | | | | | | | | • | | | | • | | | 2 |
| *Eudistoma olivaceum* | | | | | • | | | • | | • | • | | • | | 5 |
| *Eudistoma recifense** | | | | | | | | • | • | | • | | | | 3 |
| **Stomozoidae** | | | | | | | | | | | | | | | |
| *Stomozoa roseola* | • | | | | | | | | | | | | | | |
| **Holozoidae** | | | | | | | | | | | | | | | |
| *Distaplia bermudensis* | | | | | | | | • | | | | | | | 1 |
| **Didemnidae** | | | | | | | | | | | | | | | |
| *Polysyncraton amethysteum* | | | | | | | | • | | | • | | | | 2 |
| *Lissoclinum fragile* | | | | | | | | | | | | • | | | 1 |
| *Didemnum duplicatum* | | | • | • | | | | • | • | | • | | | | 5 |
| *Didemnum granulatum** | | | | | | | | • | | | | • | | | 2 |
| **Polyclinidae** | | | | | | | | | | | | | | | |
| *Polyclinum constellatum* | | | | | | | | | | • | | | | | 1 |
| **Euherdmaniidae** | | | | | | | | | | | | | | | |
| *Euherdmania fasciculata** | | | | | | | | | | | • | • | | | 2 |
| *Euherdmania* aff. *vitrea** | | | | | | | | • | • | | | | | | 2 |
| **Order Stolidobranchia** | | | | | | | | | | | | | | | |
| **Styelidae** | | | | | | | | | | | | | | | |
| *Polycarpa cartilaginea** | | | • | | | | • | | | | | | | | 2 |
| *Polycarpa spongiabilis* | | | • | | | | • | | | | | | | | 2 |
| *Botrylloides magnicoecus** | | | | | | | | • | | | | | | | 1 |
| *Botrylloides niger* | • | • | • | | | • | | | | • | | | | | 3 |
| **Pyuridae** | | | | | | | | | | | | | | | |
| *Pyura* sp. 1 | | | | | | | | | • | | • | | | | 2 |
| *Microcosmus exasperatus* | | | | | | | | | • | | • | | | • | 2 |
| **Molgulidae** | | | | | | | | | | | | | | | |
| *Molgula occidentalis* | | | | | | | | | | | | | | • | 1 |

**Table 2.** Study localities in south of Gulf of Mexico.

| Localities | Latitude | Longitude |
|---|---|---|
| Progreso Harbor | | |
| Pro 1 | 21°19'56.4"N | 89°41'17.8"W |
| Pro 2 | 21°20'58.1"N | 89°40'49.1"W |
| Pro 3 | 21°21'41.12"N | 89°41'7.02"W |
| Reef Arcas Cay | | |
| Arc 1 | 20°12'11"N | 91°58'56"W |
| Arc 2 | 20°12'13"N | 91°58'34"W |
| Arc 3 | 20°12'16.62"N | 91°57'48.13"W |
| Arc 4 | 20°12'16.9"N | 91°58'39.8"W |
| Arc 5 | 20°12'17.17"N | 91°57'48.06"W |
| Arc 6 | 20°12'19.95"N | 91°57'39.19"W |
| Arc 7 | 20°12'31.1"N | 91°57'51.37"W |
| Arc 8 | 20°12'32.14"N | 91°57'41.04"W |
| Arc 9 | 20°12'35.6"N | 91°58'0.7"W |
| Arc 10 | 20°12'36.36"N | 91°57'51.08"W |
| Arc 11 | 20°12'41.6"N | 91°57'49.1"W |
| Arc 12 | 20°12'56.6"N | 91°58'31.3"W |
| Reef Arenas Cays | | |
| Arn 1 | 22°6'12.73"N | 91°23'41.64"W |
| Arn 2 | 22°6'54.11"N | 91°23'42.17"W |
| Reef Madagascar | | |
| Mad 1 | 21°26'16.1"N | 90°16'36.6"W |
| Mad 2 | 21°26'16.4"N | 90°16'39.3"W |
| Mad 3 | 21°26'17.5"N | 90°16'34.9"W |
| Mad 4 | 21°26'17.7"N | 90°16'39.7"W |
| Reef Bajo 10 | | |
| B10 | 21°20'58"N | 90°8'52.3"W |
| Celestún | | |
| Cel 1 | 20°46'43.4"N | 90°25'36.1"W |
| Cel 2 | 20°49'0.4"N | 90°25'59.3"W |
| Champotón | | |
| Chp 1 | 19°21'18.98"N | 90°43'35.77"W |
| Chp 2 | 19°21'41.8"N | 90°43'3.4"W |
| Coastal Lagoon Chelém | | |
| Chel 1 | 21°15'47"N | 89°44'28.82"W |
| Chel 2 | 21°15'55.26"N | 89°42'39.08"W |
| Mahahual Harbor | | |
| Mha | 18°42'30"N | 87°42'40"W |
| Sisal Harbor | | |
| Sis | 21°10'4.29"N | 90°1'55.3"W |
| Ría Lagartos | | |
| Lar 1 | 21°43'19.9"N | 88°13'11.8"W |
| Lar 2 | 21°43'23.6"N | 88°13'6.5"W |
| Lar 3 | 21°43'8.4"N | 88°12'27.1"W |
| Seybaplaya | | |
| Sey 1 | 19°39'3.3"N | 90°42'31.4"W |
| Sey 2 | 19°40'44.3"N | 90°45'20.6"W |
| Sey 3 | 19°44'11.7"N | 90°48'22.8"W |
| Reef Tuxpan | | |
| Tux | 21°1'21.5"N | 97°11'27.4"W |
| Veracruz Reef | | |
| VeR | 19°12'25.5"N | 97°4'7"W |

## Systematics

## Subphylum Tunicata Lamarck, 1816

## Class Ascidiacea Blainville, 1824

## Order Phlebobranchia Lahille, 1886

## Family Ascidiidae Herdman, 1882

## Genus *Ascidia* Linnaeus, 1767

### *Ascidia panamensis* Bonnet & Rocha, 2011

Fig. 2A

**Material examined.** CAGoM-0023, Mad 1, 9 m, 20-04-2015, leg. L. Palomino-Alvarez; CAGoM-0182, Arc 3, 3 m, 30-10-2015, leg. L. Palomino-Alvarez; CAGoM-0187, CAGoM-00189, Arc 6, 2 m, 30-10-2015, leg. L. Palomino-Alvarez; CAGoM-0190, CAGoM-0191, Arc 8, 2 m, 31-10-2015, leg. L. Palomino-Alvarez.

**Remarks.** These specimens are of uniformly dark coloration inside the siphons, in contrast to specimens from Panama which have white lines between the siphon lobes (Bonnet and Rocha 2011a). Mexican specimens are also smaller with conical papillae on the tunic in the area of the oral siphon, the shape of the dorsal tubercle is variable, and the anus is smooth. All specimens were found under rocks, two to three specimens per rock, in association with *Polycarpa cartilaginea* (Sluiter, 1898) and *Corella minuta* Traustedt, 1882. Symbiosis was also noted with palaemonid crustaceans (*Ascidonia miserabilis* (Holthuis, 1951)) living in the pharynx of some of the larger specimens.

**Global distribution.** Mexico (as described here) and Panamá (Bonnet and Rocha 2011a).

## Genus *Phallusia* Savigny, 1816

### *Phallusia nigra* Savigny, 1816

**Material examined.** CAGoM-0062, Pro 1, 4 m, 26-05-2015, leg. L. Palomino-Alvarez; CAGoM-0085, CAGoM-0089, Sey 1, 11 m, 12-06-2015, leg. L. Palomino-Alvarez; CAGoM-0733, Sis, 1 m, 21-03-2018, leg. Bryan Flores;

Photographed record (no specimens in the collection): Tux, 5 m, 21-09-2015.

**Remarks.** This species was only recorded on artificial substrates and shallow rocks near the shore.

**Global distribution.** United States (Van Name 1921, 1945; Plough 1978), Bermudas (Herdman 1882; Verrill 1900; Van Name 1902, 1945; Monniot 1973), Panama (Collin et al. 2005; Rocha et al. 2005; Bonnet and Rocha 2011a), Curaçao (Millar 1962; Goodbody 1984), Venezuela (Bermudez and Grimaldi 1975), Guadeloupe (Monniot 1983a), Martinique (Monniot 2018a), French Guiana (Monniot 2016),

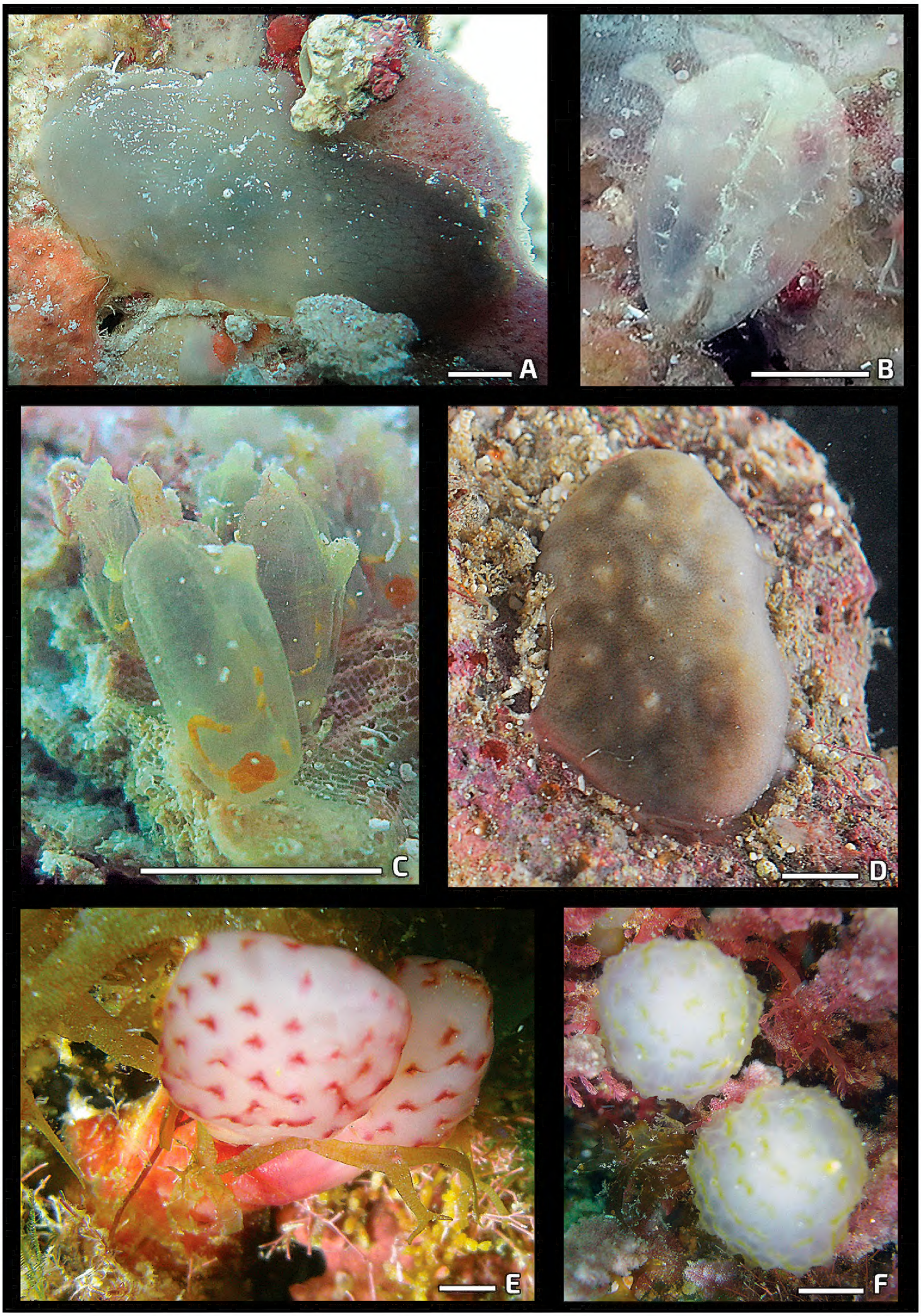


**Figure 2.** Photos of live specimens in situ in the field. **A** *Ascidia panamensis* **B** *Corella minuta* **C** *Ecteinascidia styeloides* **D** *Cystodytes roseolus* **E, F** *Eudistoma* aff. *amanitum*. Scale bar: 1 cm.

Brazil (Van Name 1921, 1945; Millar 1958; Monniot 1970; Rodrigues 1962; Rocha and Costa 2005; Bonnet and Rocha 2011a; Dias et al. 2012), South Africa (Herdman 1880), Angola (Millar 1965), Greece (Kondilatos et al. 2010), Suez Canal (Harant 1927; Ghobashy and Abdel Messeih 1991), Israel (Pérès 1958; Shenkar 2012), Red Sea (Michaelsen 1918; Savigny 1816), Micronesia (unconfirmed – Nishikawa 1984; Lambert 2003).

## Family Corellidae Lahille, 1888
## Genus *Corella* Alder & Hancock, 1870

### *Corella minuta* Traustedt, 1882
Fig. 2B

**Material examined.** CAGoM-0369, Arc 5, 2 m, 21-08-2016, leg. L. Palomino-Alvarez; CAGoM-0384, Arcas Cay Reef, Yucatán, Arc 4, 2 m, 22-08-2016, leg. L. Palomino-Alvarez; CAGoM-0447, Arcas Cay Reef, Yucatán, Arc 7, 4 m, 25-08-2016, leg. L. Palomino-Alvarez.

**Remarks.** Specimens were found in a single location under rocks, together with *A. panamensis* and *Polycarpa cartilaginea*.

**Global distribution.** United States (Van Name 1921, 1930, 1945), Curaçao (Van Name 1924), Guadeloupe (Monniot 1983), Martinique (Monniot 2018), Mozambique (Monniot 1997), Japan (Tokioka and Nishikawa 1975), New Caledonia (Monniot 1987, 1991), Micronesia (Nishikawa 1984; Lambert 2003), and French Polynesia (Monniot and Monniot 1987a).

## Family Perophoridae Giard, 1872
## Genus *Ecteinascidia* Herdman, 1880

### *Ecteinascidia styeloides* (Traustedt, 1882)
Fig. 2C

**Material examined.** CAGoM-0441, Arc 9, 9 m, 27-08-2016, leg. L. Palomino-Alvarez; CAGoM-0442, CAGoM-0444, Bajo 10 Reef, Yucatán, B10, 7 m, 19-10-2016, leg. L. Palomino-Alvarez.

**Remarks.** Colonies of many individuals and many sizes were found on seaweed and under rocks.

**Global distribution.** Jamaica (Goodbody 1984, Goodbody and Cole 2006), Guadeloupe (Monniot 1983a), Belize (Goodbody 2004; Goodbody and Cole 2006), Panama (Collin et al. 2005; Rocha et al. 2005), Venezuela (Goodbody 2004; Rocha et al. 2010), Mozambique (Monniot 1997).

### *Ecteinascidia turbinata* Herdman, 1880

**Material examined.** CAGoM-0020, Arn 2, 7 m, 03-19-2015, leg. L. Palomino-Alvarez; CAGoM-0026, CAGoM-0027, CAGoM-0028, CAGoM-0031, CAGoM-0033, CAGoM-0034, CAGoM-0035, Chel 2, 1 m, 11-05-2015, leg. L. Palomino-Alvarez; CAGoM-0054, Pro 1, 3 m, 26-05-2015, leg. L. Palomino-Alvarez; CAGoM-0063, Chp 1, 4 m, 26-05-2015, leg. L. Palomino-Alvarez; CAGoM-0171, Arc 2, 9.4 m, 30-10-2015, leg. L. Palomino-Alvarez.

**Remarks.** Colonies with the largest number of zooids were found in coastal lagoons on wooden piers or mangrove prop roots as well as coral reefs far from the shore. This was the most common species in Chelém (an enclosed, very salty, lagoon), comprising two morphotypes. Some had orange zooids and others had transparent, uncolored, zooids with a ring of orange along the siphon rim. This species was never found in disturbed port areas.

**Global distribution.** United States (Van Name 1921, 1945; Plough 1978), Bermudas (Herdman 1882; Verril 1900; Berrill 1932, 1935; Monniot 1972; Van Name 1902, 1945), Cuba (Hernández-Zanuy and Carballo 2001), Jamaica (Goodbody 2003; Goodbody and Cole 2006), Turks and Caicos Islands (Millar 1962), Mexico, Yucatán Peninsula (Carballo 2000), Belize (Goodbody 2000), Panama (Collin et al. 2005), Curacao (Goodbody 1984), Venezuela (Goodbody 1984a; Rocha et al. 2010; Carballo-Pérez and Díaz 2011), Guadeloupe (Monniot 1983a), Martinique (Monniot 2018a), Guyana (Millar 1978), French Guiana (Monniot 2016), Senegal (Pérès 1949, 1951; Lafargue and Wahl 1990; Monniot and Monniot 1994), Sierra Leone (Millar 1956), Gibraltar (Naranjo and García-Gómez 1994), Baleares Islands (Ramos et al. 1993; Spain (Casso et al. 2018), France (Harant 1927, Harant and Vernières 1933, Thessalou-Legaki et al. 2012), Tunisia (Pérès 1954), and Egypt (Harant 1927).

## Order Aplousobranchia Lahille, 1886
## Family Clavelinidae Forbes & Hanley, 1848
## Genus *Clavelina* Savigny, 1816

### *Clavelina oblonga* Herdman, 1880

**Material examined.** CAGoM-0081, CAGoM-0082, Sey 3, 11 m, 19-03-2015, leg. L. Palomino-Alvarez; CAGoM-0093, Mad 2, 7 m, 27-05-2015, leg. L. Palomino-Alvarez.

**Remarks.** Specimens from Seybaplaya, Campeche were associated with the hydroid *Macrorhynchia philippina* Kirchenpauer, 1872 (Cnidaria: Hydrozoa), from which they may gain protection from predators. The details of this association should be investigated.

**Global distribution.** United States (Van Name 1945; Plough 1978; Lambert et al. 2005), Bermudas (Herdman 1880, 1882; Monniot 1972; Van Name 1902, 1945; Verrill

1900; Berrill 1932), Jamaica (Goodbody 1993, 2003), Southwestern Gulf of Mexico (Van Name 1921), Curaçao (Goodbody 1984; Millar 1962),Venezuela (Rocha et al. 2010), Guadeloupe (Monniot 1983), Tobago (Cole 2012), Brazil (Millar 1958; Rocha et al. 2005a; Rocha and Costa 2005; Rocha and Kremer 2005; Rodrigues et al. 1998), Azores (Monniot and Monniot 1994), Madeira (Harant 1929); Senegal (Pérès 1951; Monniot 1969; Lafargue and Wahl 1987), Spain and Italy (Ordóñez et al. 2016; Casso et al. 2018).

### *Clavelina* sp.

**Material examined.** CAGoM-0006, CAGoM-0007, Arn 1, 2 m, 19-03-2015, leg. L. Palomino-Alvarez; CAGoM-0021, Arn 2, 6 m, 19-03-2015, leg. L. Palomino-Alvarez.

**Remarks.** This species is dark blue with characteristics that do not match any known species and will be described elsewhere. The single colony found was small with few zooids (Table 1).

## Family Polycitoridae Michaelsen, 1904
## Genus *Cystodytes* Drasche, 1884

### *Cystodytes dellechiajei* (Della Valle, 1877)

**Material examined.** CAGoM-0135, CAGoM-0449, B10, 11 m, 17-06-2015, *leg.* L. Palomino-Alvarez.

**Remarks.** This is the only known west Atlantic species of the genus which has been reported from nine countries, both in tropical and subtropical regions (Rocha et al. 2005, 2012). The species is very rare in the southern Gulf of Mexico (Table 1); it has been found in shallow waters of the northern Gulf of Mexico in Florida (Van Name 1945).

**Global distribution.** United States (Van Name 1945; Plough 1978); Bermudas (Monniot 1972; Van Name 1902, 1945), Panamá (Collin et al. 2005), Les Saints, Martinique (Gravier 1955), Guyana (Millar 1977), Brazil (Millar 1977; Rocha et al. 2005), Azores (Michaelsen 1923; Monniot 1971; Monniot and Monniot 1994; Monniot 1975), Canary Islands (Ríos 1985), Senegal (Michaelsen 1915; Monniot 1969; Pérès 1949, 1951; Lafargue and Wahl 1987), Iberic Mediterranean (López-Legentil and Turon 2005), France (Harant 1927; Harant and Vernières 1933; Lafargue 1970), Italy (Drasche 1883; Brunetti 1994), Philippines (Van Name 1918), and Australia (Michaelsen 1930; Millar 1953; Kott 1990).

### *Cystodytes roseolus* Hartmeyer, 1912
Fig. 2D

**Material examined.** CAGoM-0114, B10, 11 m, 17-06-2015, leg. L. Palomino-Alvarez; CAGoM-0043, Pro 2, 7 m, 26-05-2015, leg. L. Palomino-Alvarez; CAGoM-0064, Chp 1,

2 m, 26-05-2015, leg. L. Palomino-Alvarez; CAGoM-0105, Mad 4, 5 m, 17-06-2015, leg. L. Palomino-Alvarez; CAGoM-0465, B10, 11 m, 17-06-2015, leg. L. Palomino-Alvarez.

**Remarks.** *Cystodytes roseolus* might have been found in Atlantic Panama in 2003 but identification needs to be confirmed due to the disjunct distribution (Rocha et al. 2005). This second report of the species in the Gulf of Mexico indicates that this species occurs on both sides of the Atlantic. Finding this species in Progreso Harbor and nearby locations suggests that this species was introduced to the Yucatán peninsula from Africa by ship transport.

**Global distribution.** Senegal (Pérès 1949; Monniot 1969; Lafargue and Wahl 1987; Monniot and Monniot 1994), South Africa (Hartmeyer 1912; Michaelsen 1919, 1934; Millar 1962), Seychelles (Michaelsen 1919).

## Genus *Eudistoma* Caullery, 1909

### *Eudistoma* aff. *amanitum* Paiva & Rocha, 2018

Fig. 2E, F

**Material examined.** CAGoM-0074, Mad 2, 9 m, 27-05-2015, leg. L. Palomino-Alvarez; CAGoM-0070, Mad 2, 10 m, 27-05-2015, leg. L. Palomino-Alvarez; CAGoM-0100, Mad 4, 12 m, 17-06-2015, leg. L. Palomino-Alvarez; CAGoM-0112, B10, 7 m, 17-06-2015, leg. L. Palomino-Alvarez; CAGoM-0115, B10, 9 m, 17-06-2015, leg. L. Palomino-Alvarez; CAGoM-0139, CAGoM-0140, CAGoM-0142, Lar 1, 10 m, 07-10-2015, leg. L. Palomino- Alvarez; CAGoM-0149, CAGoM-0150, Lar 2, 10 m, 07-10-2015, leg. L. Palomino-Alvarez; CAGoM-0152, Lar 2, 12 m, 07-10-2015, leg. L. Palomino-Alvarez; CAGoM-0163, Lar 3, 12 m, 07-10-2015, leg. L. Palomino-Alvarez.

**Remarks.** Colonies from Mexico and Panama vary by location in the number of heads per peduncle and shape, zooid size, zooid position within the tunic, and color (Paiva and Rocha 2018). Gonads were undeveloped and no larvae were found, thus this species identification remains to be confirmed.

**Global distribution.** Southern Gulf of Mexico (described herein) and Panama (Paiva and Rocha 2018).

### *Eudistoma clarum* (Van Name, 1902)

**Material examined.** CAGoM-0041, Pro 3, 8 m, 26-05-2015, leg. L. Palomino-Alvarez; CAGoM-0051, Pro 1, 14 m, 26-05-2015, leg. L. Palomino-Alvarez; CAGoM-0077, Mad 3, 12 m, 27-05-2015, leg. L. Palomino-Alvarez; CAGoM-0103, Mad 4, 9 m, 27-05-2015, leg. L. Palomino-Alvarez; CAGoM-00166, Lar 3, 12 m, 07-10-2015, leg. L. Palomino-Alvarez.

**Remarks.** Records of *E. clarum* have been found in mangroves and to a depth of 20 m in coral reefs (Goodbody, 2000). We found specimens mainly in coral reefs and near shore in places with strong anthropogenic impact.

**Global distribution.** United States (Van Name 1921), Bermudas (Van Name 1902, 1945; Berrill 1932; Monniot 1972), Belize (Goodbody 2000), Panama (Collin et al. 2005; Rocha et al. 2005), Bonaire (Millar 1962), Venezuela and Caribbean Islands (Millar 1962; Goodbody 1984), Tobago (Cole 2012), Guadeloupe (Monniot 1983), Senegal (Pérès 1949), and French Polynesia (Monniot and Monniot 1987a).

### *Eudistoma hepaticum* (Van Name, 1921)

Fig. 3G

**Material examined.** CAGoM-0052, Pro 1, 6 m, 26-05-2015, leg. L. Palomino-Alvarez; CAGoM-0068, Chp1, 26-05-2015, 2 m, leg. L. Palomino-Alvarez; CAGoM-0091, Sey 2, 12-06-2015, 11 m, leg. Palomino-Palomino Alvarez; CAGoM-0088, Sey 1, 12-06-2015, 11 m, leg. Palomino-Palomino Alvarez; CAGoM-0107, Mad 4, 17-06-2015, 9 m, leg. L. Palomino-Alvarez; CAGoM-0072, Mad 2, 13 m, 27-05-2015, leg. L. Palomino-Alvarez; CAGoM-0039, Cel 1, 11-05-2015, 1 m, leg. L. Palomino-Alvarez, CAGoM-0116, B10, 9 m, 17-06-2015, leg. L. Palomino-Alvarez; CAGoM-0087, Sey 2, 11 m, 12-06-2015, leg. L. Palomino-Alvarez.

**Remarks.** We found large (about 20 cm in diameter) purple or blue colonies on cement columns in Progreso Harbor and smaller colonies were found on coral reefs. This is the most common species of *Eudistoma* in the region.

**Global distribution.** United States (Van Name 1945; Plough 1978), Bermudas (Van Name 1902), Jamaica (Goodbody 2003, Van Name 1921), St. Thomas (Van Name 1921), Mexico (Van Name 1945), Curaçao (Goodbody 1984b), Venezuela (Goodbody 1984a), and Guadeloupe (Monniot 1983c).

### *Eudistoma obscuratum* (Van Name, 1902)

**Material examined.** CAGoM-0073, Mad 2, 8 m, 27-05-2015, leg. L. Palomino-Alvarez; CAGoM-0101, CAGoM-0109, Mad 4, 12 m, 17-06-2015, leg. L. Palomino-Alvarez; CAGoM-0159, Lar 2, 14 m, 07-10-2015, leg. L. Palomino-Alvarez.

**Remarks.** Colonies are small and found beneath rocks and on bivalve shells.

**Global distribution.** United States (Van Name 1921, 1945), Bermuda (Monniot 1972; Van Name 1902, 1945), Virgin Islands (Van Name 1921, 1945), and Belize (Goodbody 2000).

### *Eudistoma olivaceum* (Van Name, 1902)

Fig. 3H

**Material examined.** CAGoM-0016, Mha, 1 m, 12-03-2015, leg. L. Palomino-Alvarez; CAGoM-0078, Chp 2, 0.5 m, 11-06-2015, leg. L. Palomino-Alvarez; CAGoM-0025,

Mad 4, 9 m, 04-04-2015, leg. L. Palomino-Alvarez; CAGoM-0060, Pro 1, 8 m, 26-05-2015, leg. L. Palomino-Alvarez; CAGoM-0036, Chel 2, 11-05-2015, 1 m, leg. L. Palomino-Alvarez.

**Remarks.** Zooids of some samples have a third opening at the base of the thorax through which fecal pellets are expelled. While colonies appeared healthy, this third opening may have been due to body wall rupture caused by obstruction of the atrial canal by incubating larvae in the atrial cavity or excess sediments in the water. The appearance of third siphons may be induced by experimental injuries in a few solitary ascidians (Jeffery et al. 2015).

**Global distribution.** United States (Van Name 1921, 1945; Plough 1978), Bermudas (Berrill 1932; Monniot 1972; Van Name 1902, 1945), Jamaica (Goodbody 2003), Cuba (Van Name 1921), Puerto Rico (Van Name 1921), Guadeloupe (Monniot 1983c), Belize (Goodbody 2004), Curaçao (Van Name 1924; Millar 1962; Goodbody 1984), Venezuela (Millar 1962; Goodbody 1984a), Tobago (Cole 2012), Senegal (Lafargue and Wahl 1987), Micronesia (Nishikawa 1984).

### *Eudistoma recifense* Millar, 1977

Fig. 3I

**Material examined.** CAGoM-0071, Mad 2, 11 m, 27-05-2015, leg. L. Palomino-Alvarez; CAGoM-0047, Pro 1, 8 m, 26-05-2015, leg. L. Palomino-Alvarez; CAGoM-0137, B10, 11 m, 17-06-2015, leg. L. Palomino-Alvarez.

**Remarks.** Commonly found on grass beds, coral reefs and cement columns of harbors near the shore.

**Global distribution.** Southern Gulf of Mexico (present study) and Brazil (Millar 1977; Oliveira et al. 2014).

## Family Stomozoidae Kott, 1990

## Genus *Stomozoa* Kott, 1957

### *Stomozoa roseola* (Millar, 1955)

**Material examined.** CAGoM-0076, Mad 3, 12 m, 27-05-2015, leg. L. Palomino-Alvarez; CAGOM-69, Chp 1, 5 m, 26-05-2015, leg. L. Palomino-Alvarez.

**Remarks.** Colonies were found on dead coral and between large rocks. The tunic is very firm and dark purple, similar to colonies from the Red Sea and Madagascar.

**Global distribution.** United States (Van Name 1945; Plough 1978); Mexico (Van Name 1945), French Guiana (Monniot 2016), Brazil (Millar 1977), South Africa (Millar 1955), Madagascar (Monniot 2012), Red Sea (Kott 1957), Indonesia (Monniot and Monniot 1996), and New Caledonia (Monniot 1988).

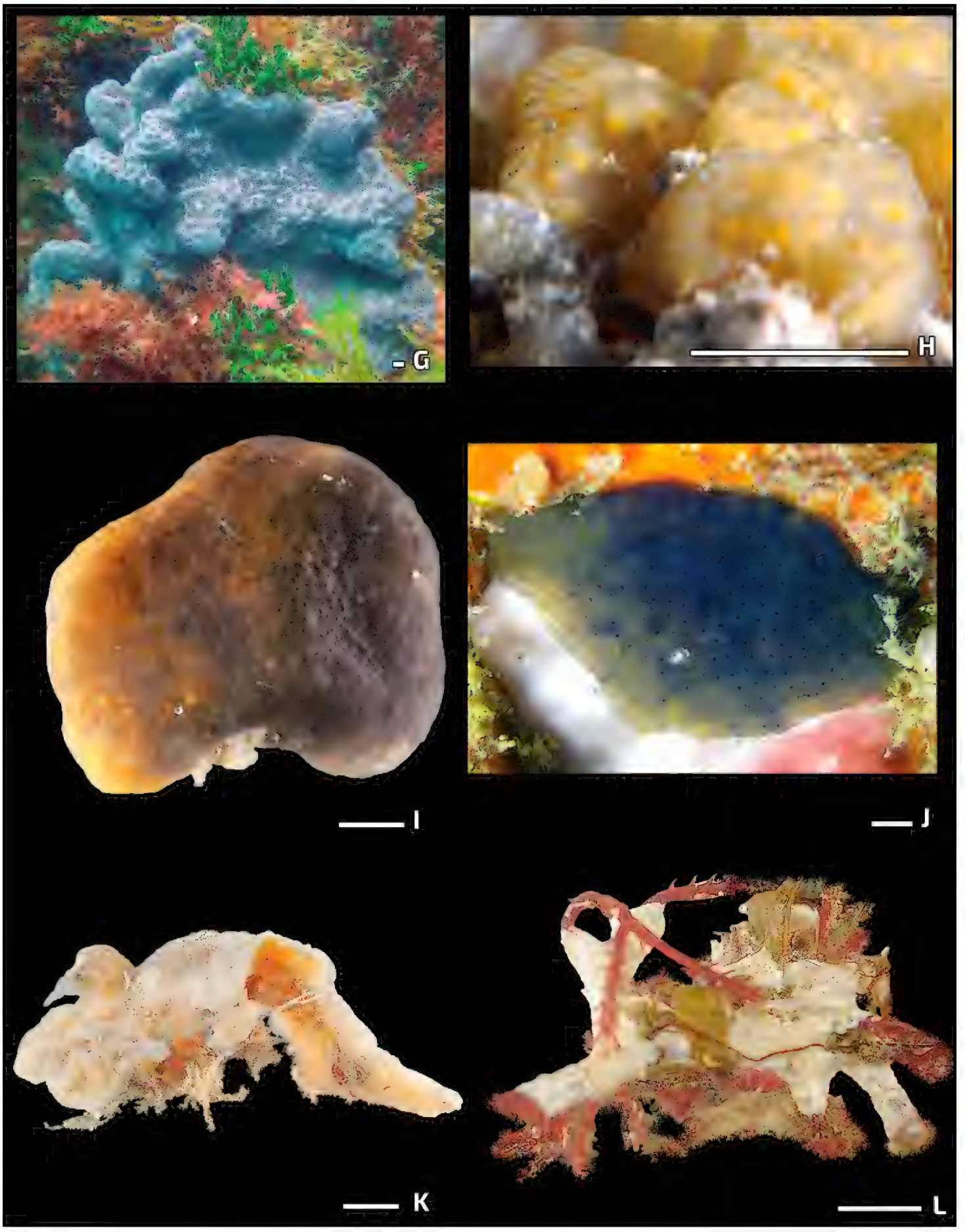


**Figure 3.** Photos of live specimens in the field (continued). **G** *Eudistoma hepaticum* **H** *Eudistoma olivaceum* **I** *Eudistoma recifense* **J** *Distaplia bermudensis* **K** *Polysyncraton amethysteum* (preserved specimen) **L** *Lissoclinum fragile*. Scale bar: 1 cm.

**Family Holozoidae Berrill, 1950**
**Genus *Distaplia* Della Valle, 1881**

***Distaplia bermudensis* Van Name, 1902**
Fig. 3J

**Material examined.** CAGoM-00102, Mad 4, 14 m, 17-06-2015, leg. L. Palomino-Alvarez; CAGoM-0095 Mad 4, 17-06-2015, 9 m, leg. L. Palomino-Alvarez.

**Remarks.** Although this species is common in many Caribbean countries, we found it in only one location.

**Global distribution.** United States (Van Name 1921, 1945; Plough 1978), Bermudas (Van Name 1902, 1945; Berrill 1932; Gravier 1955; Monniot 1972), Cuba (Hernandez 1990), Jamaica (Goodbody 2003), Puerto Rico (Van Name 1921), Virgin Islands, St Thomas (Van Name 1921), Guadeloupe (Monniot 1983); Belize (Goodbody 2004), Panamá (Collin et al. 2005, Rocha et al. 2005), Curaçao (Millar 1962; Goodbody 1984), Venezuela (Millar 1962; Goodbody 1984; Rocha et al. 2010), Guyana (Millar 1978), French Guiana (Monniot 2016), Brazil (Millar 1958, 1977; Rodrigues and Rocha 1993; Rodrigues et al. 1998; Rocha et al. 2005; Rocha and Costa 2005; Rocha and Kremer 2005), Senegal (Pérès 1949), and Italy (Mastrototaro and Brunetti 2006).

**Family Didemnidae Giard, 1872**
**Genus *Polysyncraton* Nott, 1892**

***Polysyncraton amethysteum* Van Name, 1902**
Fig. 3K

**Material examined.** CAGoM-0158, Lar 2, 9 m, 07-10-2015, leg. L. Palomino-Alvarez; CAGoM-0118, B10, 9 m, 17-06-2015, leg. L. Palomino-Alvarez.

**Remarks.** Colony found on corals and rocks. Orange zooids when alive and in preservation.

**Global distribution.** United States (Van Name 1921), Bermuda (Van Name 1902, 1921, 1945), Puerto Rico (Van Name 1945), Guadeloupe (Gravier 1955), Martinique (Gravier 1955); Colombia (Van Name 1945), French Guiana (Monniot 2016), Brazil (Millar 1958, 1977; Rodrigues and Rocha 1993; Rocha et al. 2005; Rocha and Kremer 2005), Cape Verde (Monniot and Monniot 1967), Senegal (Pérès 1948, 1949), Ghana (Millar 1953), Tunisia (Pérès 1954).

## Genus *Lissoclinum* Verrill, 1871

### *Lissoclinum fragile* (Van Name, 1902)

Fig. 3L

**Material examined.** CAGoM-0143, Lar 1, 12 m, 07-10-2015, leg. L. Palomino-Alvarez.

**Remarks.** We found colonies in a single location growing on algae. *Lissoclinum fragile* is reported from tropical and subtropical regions where it is very common in marinas on artificial substrates, which suggests that is has been extensively introduced while the original geographical distribution remains unknown.

**Global distribution.** United States (Van Name 1921; Lambert et al. 2005), Bermuda (Van Name 1902; Berrill 1932), St Thomas (Van Name 1921), Jamaica (Goodbody 1993), Guadeloupe (Monniot 1983a), Belize (Goodbody 2004), Costa Rica (Tokioka 1972), Curaçao (Millar 1962; Van Name 1924), Venezuela (Millar 1962; Rocha et al. 2010), Tobago (Cole 2012), Brazil (Rodrigues et al. 1998; Rocha and Kremer 2005; Rocha and Faria 2005), Azores (Monniot 1974), Sierra Leone (Monniot and Monniot 1994), Madagascar (Vasseur 1970), Persian Gulf (Monniot 1997), India (Renganathan 1982), Philippines (Tokioka 1967), Indonesia (Lafargue and Vasseur 1989), Japan (Tokioka 1954), New Caledonia (Monniot 1992), Guam (Monniot and Monniot 2001; Lambert 2003), and French Polynesia (Monniot and Monniot 1987a; Monniot et al. 1985).

## Genus *Didemnum* Savigny, 1816

### *Didemnum duplicatum* Monniot, 1983

**Material examined.** CAGoM-050, CAGoM-0475, Pro 1, 13 m, 26-05-2015, leg. L. Palomino-Alvarez; CAGoM-0080, Sey 3, 8 m, 12-06-2015, leg. L. Palomino-Alvarez; CAGoM-0108, Mad 4, 11 m, 17-06-2015, leg. L. Palomino-Alvarez; CAGoM-0126, CAGoM-0133, B10, 7 m, 17-06-2015, leg. L. Palomino-Alvarez; CAGoM-0186, Arc 6, 8 m, 30-10-2015, leg. L. Palomino-Alvarez.

**Remarks.** Colonies were found only near shore (harbors) and on artificial reefs. Recent molecular unpublished data (RMR) suggests that this might by a complex of three species.

**Global distribution.** United States (Lambert et al. 2005), Jamaica (Goodbody 2003), Guadeloupe (Monniot 1983a), Belize (Goodbody 2000), Curaçao (Goodbody 1984), Venezuela (Goodbody 1984; Rocha et al. 2010), Tobago (Cole 2012), French Guiana (Monniot 2016).

### *Didemnum granulatum* Tokioka, 1954

**Material examined.** CAGoM-0075, Mad 3, 7 m, 27-05-2015, leg. L. Palomino-Alvarez; CAGoM-0153, Lar 2, 10 m, 07-10-2015, leg. L. Palomino-Alvarez.

**Remarks.** With a global distribution, *D. granulatum* is known to rapidly colonize artificial substrates (Oren and Benayahu 1998), so it may be widely introduced, but its origin is unknown. In the southern Gulf of Mexico colonies were found on corals, rocks and algae near shore.

**Global distribution.** Panama (Rocha et al. 2005), French Guiana (Monniot 2016), Brazil (Dias et al. 2012; Paiva et al. 2015), Senegal (Monniot and Monniot 1994), South Africa (Monniot et al. 2001), Red Sea (Shenkar 2012), Hong Kong (Kott and Goodbody 1982), Philippines (Monniot and Monniot 2001), Papua New Guinea (Monniot and Monniot 2001), Japan (Tokioka 1954), Australia (Kott 2001), New Caledonia (Monniot 1995), French Polynesia (Monniot and Monniot 1987a), and Fiji (Kott 1981).

**Family Polyclinidae Milne Edwards, 1841**
**Genus *Polyclinum* Savigny, 1816**

***Polyclinum constellatum* Savigny, 1816**
Fig. 4M

**Material examined.** CAGoM-0731, CAGoM-0732, CAGoM-0736, Chel 1, 0 m, 21-03-2018, leg. R.M. Rocha.

**Remarks.** This is another widespread species that was probably introduced in the southern Gulf of Mexico, yet we only found it in one harbor. The high salinity tolerance has been observed in Margarita Island, Venezuela where the species has also been found in an estuary with salinity > 50 ppt (Rocha et al. 2010).

**Global distribution.** United States (Van Name 1945), Gulf of Mexico (Van Name 1945; Lambert et al. 2005), Bahamas (Van Name 1945), Bermuda (Monniot 1972), Cuba (Van Name 1945), Jamaica (Van Name 1945, Goodbody 1993), Puerto Rico (Van Name 1921), Guadeloupe (Monniot 1983b), Martinique (Gravier 1955), Belize (Goodbody 2000), Panama (Carman et al. 2010), Colombia (Van Name 1945), Curaçao (Millar 1962; Goodbody 1984), Venezuela (Rocha et al. 2010; Carballo-Pérez and Díaz 2011), French Guiana (Monniot 2016), Brazil (Millar 1958; Rodrigues and Rocha 1993; Rocha et al. 2005, 2011), South Africa (Millar 1955), Mozambique (Michaelsen 1919, Monniot and Monniot 1976), Madagascar (Vasseur 1970), Mauritius Island (Savigny 1816), Persian Gulf (Monniot and Monniot 1997), Japan (Tokioka 1963, 1967), China (Michaelsen 1923), New Caledonia (Monniot 2007).

**Family Euherdmaniidae Ritter, 1904**
**Genus *Euherdmania* Ritter, 1904**

***Euherdmania fasciculata* Monniot, 1983**

**Material examined.** CAGoM-00471, Pro 1, 13 m, 26-05-2015, leg. L. Palomino-Alvarez.

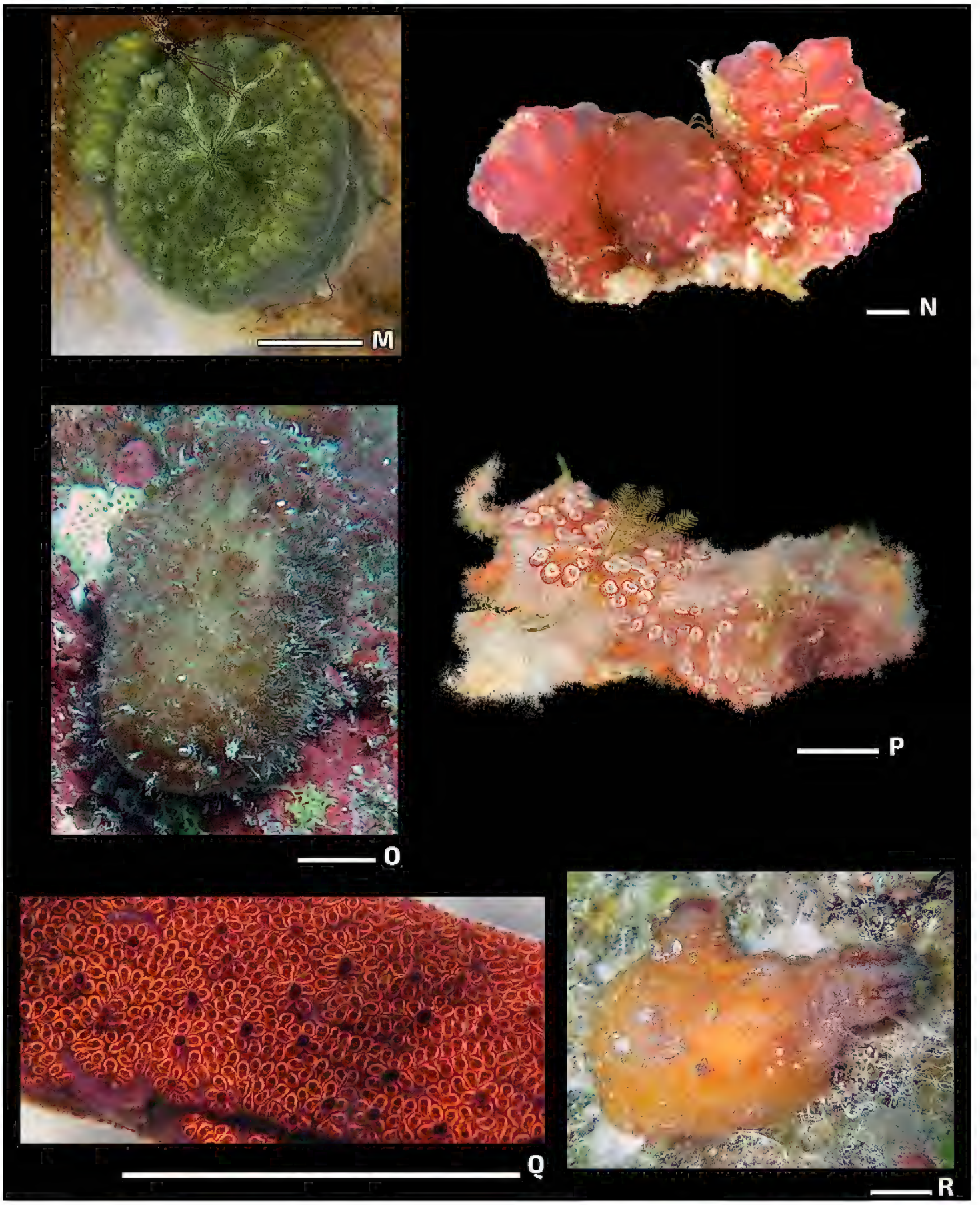


**Figure 4.** Photos of live specimens in the field (continued). **M** *Polyclinum constellatum* **N** *Euherdmania* aff. *vitrea* **O** *Polycarpa cartilaginea* **P** *Botrylloides magnicoecus* **Q** *Botrylloides niger* **R** *Microcosmus exasperatus*. Scale bar: 1 cm.

**Remarks.** The specimen was found in a disturbed environment (near-shore artificial reef).

**Global distribution.** Southern Gulf of Mexico (present study), Guadeloupe (Monniot 1983b), French Guiana (Monniot 2016)

***Euherdmania* aff. *vitrea* Millar, 1961**
Fig. 4N

**Material examined.** CAGoM-00104, Mad 4, 11 m, 17-06-2015, leg. L. Palomino-Alvarez; CAGoM-00120, B10, 10 m, 17-06-2015, leg. L. Palomino-Alvarez.

**Remarks.** Morphological patterns of colony shape, zooids completely embedded in the tunic, conspicuous musculature throughout the body, number of siphon lobes, number of stigmatal rows, and the testis position correspond with *E. vitrea* by Millar (1961), but the absence of the developed gonads and larvae prevent confirmation of this species. Also, the tunic is dark red colored while all colonies collected in Brazil are uncolored.

**Global distribution.** Southern Gulf of Mexico (present study), Brazil (Millar 1961; Rocha et al. 2005).

**Order Stolidobranchia Lahille, 1886**
**Family Styelidae Sluiter, 1895**
**Genus *Polycarpa* Heller, 1877**

***Polycarpa cartilaginea* (Sluiter, 1898)**
Fig. 4O

**Material examined.** CAGoM-0010, Arn 1, 12 m, 19-03- 2015, leg. L. Palomino-Alvarez; CAGoM-0176, Arc 1, 4 m, 19-03- 2015, leg. L. Palomino-Alvarez; CAGoM-0364, CAGoM-0365, Arc 11, 7 m, 20-08- 2016, leg. L. Palomino-Alvarez; CAGoM-0386, CAGoM-00468, Arc 4, 6 m, 22-08-2016, leg. L. Palomino-Alvarez; CAGoM-0408, CAGoM-412, CAGoM-0420, CAGoM-0421, Arc 12, 6 m, 24-08-2016, leg. L. Palomino-Alvarez; CAGoM-0426, CAGoM-0479, Arc 7, 9 m, 25-08-2016, leg. L. Palomino-Alvarez; CAGoM-0437, Acr 10, 12 m, 26-08- 2016, leg. L. Palomino-Alvarez.

**Remarks.** All the specimens from Arcas Cay Reef were found under large rocks with other species of ascidians (*Ascidia panamensis*, *Corella minuta* and *Ecteinascidia styeloides*).

**Global distribution.** Belize (Goodbody 2000), Panama (Collin et al. 2005; Rocha et al. 2005), Curaçao (Millar 1962; Van der Sloot 1969; Goodbody 1984), Colombia (Sluiter 1898), Guadeloupe (Monniot 1983), Martinique (Monniot 2018b).

***Polycarpa spongiabilis* Traustedt, 1883**

**Material examined.** CAGoM-0022, Arn 2, 6 m, 19-03- 2015, leg. L. Palomino-Alvarez; CAGoM-0448, Arc 10, 4 m, 26-08-2016, leg. L. Palomino-Alvarez.

**Remarks.** Amphipods were found between folds of the pharynx of *P. spongiabilis* (two males of *Leucothoe wuriti* Thomas & Klebba, 2007).

**Global distribution.** United States (Van Name 1921, 1945; Plough 1978), Bermuda (Verrill 1900; Van Name 1902, 1945; Gravier 1955; Monniot 1972), Cuba (Hernandez 1990), Jamaica (Sluiter 1898; Goodbody 1993), Puerto Rico (Van Name 1921, 1930), St. Thomas (Traustedt 1883), Guadeloupe (Gravier 1955; Monniot 1983b), Martinique (Monniot 2018b), Belize (Goodbody 2000), Panamá (Collin et al. 2005; Rocha et al. 2005), Curaçao (Sluiter 1898; Goodbody 1984), Venezuela (Sluiter 1898; Goodbody 1984; Rocha et al. 2010), Tobago (Cole 2012), Guyana (Millar 1978), Brazil (Rodrigues 1962; Millar 1977; Rocha and Kremer 2005).

## Genus *Botrylloides* Milne Edwards, 1841

### *Botrylloides magnicoecus* (Hartmeyer, 1912)

Fig. 4P

**Material examined.** CAGoM-0125, B10, 11 m, 17-06-2015, leg. L. Palomino-Alvarez.

**Remarks.** This is the first record of *B. magnicoecus* in the Gulf of Mexico. General characteristics agree with descriptions by Brunetti (2010), but caecum size in the Mexico specimens is larger.

**Global distribution.** According to Brunetti (2010) the records from South Africa have characteristics in agreement with the type and are trustful (Michaelsen 1934; Millar 1955). Recently a new record from French Guiana (Monniot 2016) has been published. A more detailed study of the species in the type locality should be performed to permit the revision of other records in the Atlantic (Guadeloupe – Monniot 1983b, Belize – Goodbody 2004).

### *Botrylloides niger* Herdman, 1886

Fig. 4Q

**Material examined.** CAGoM-0029, CAGoM-0030, CAGoM-0032, CAGoM-0037, CAGoM-0038, Chel 2, 1 m, 11-05-2015, leg. L. Palomino-Alvarez; CAGoM-0040, Cel 2, 1 m, 11-05-2015, leg. L. Palomino-Alvarez; CAGoM-0185, Arc 3, 3 m, 30-10-2015, leg. L. Palomino-Alvarez.

**Photographed record (no specimens in collection):** VeR, 8 m, 20-09-2015, L. Palomino-Alvarez

**Remarks.** *Botrylloides niger* is among the species considered common and abundant in tropical waters (Rocha et al. 2010) with a widespread geographical distribution, where it attaches to natural and artificial substrates (Sheets et al. 2016 – as *B. nigrum*). We found it beneath rocks, on coral reefs, in ports and lagoons.

**Global distribution.** United States (Van Name 1945), Mexico (Van Name 1945), Bermuda (Herdman 1886; Van Name 1902, 1945; Monniot 1972), Belize (Goodbody 2000), Panama (Carman et al. 2011), Curaçao (Goodbody 1984), Bonaire (Millar 1962), Venezuela (Rocha et al. 2010; Carballo-Pérez and Díaz 2011), Cuba (Van Name 1945),

Jamaica (Goodbody 2003), Puerto Rico (Van Name), Guadeloupe (Monniot 1983b), Martinique (Monniot 2018b as *B. nigrum*), Antilles (Gravier 1955; Van Name 1930), Tobago (Cole 2012), Brazil (Rodrigues 1962; Rocha and Costa 2005; Rocha and Kremer 2005; Rocha and Bonnet 2009; Dias et al. 2012), Morocco (Millar 1698), Senegal (Monniot 1969), Israel Mediterranean (Sheets et al. 2016), Singapore (Sheets et al. 2016), Somalia (Millar 1988), Madagascar (Vasseur 1970), French Polynesia (Monniot et al. 1985).

## Family Pyuridae Hartmeyer, 1908
## Genus *Pyura* Molina, 1782

### *Pyura* sp.

**Material examined.** CAGoM-0129, CAGoM-0128, CAGoM-0134, B10, 11 m, 17-06-2017, leg. L. Palomino-Alvarez; CAGoM-0160, CAGoM-0162, CAGoM-0146, Pro 1, 7 m, 26-05-2015, leg. L. Palomino-Alvarez.

**Remarks.** Specimens were compared with Panamanian specimens and are similar to a new species being described (Skinner et al. in press). In Yucatan peninsula they are 9–10 cm long, and were found mainly on coral reefs. Oral tentacles are more numerous (43–58) and one of the specimens had the following vessel formula:

E 11 (28) 9 (28) 6 (34) 6 (36) 5 (33) 5 (31) 6 LD 3 (30) 5 (28) 5 (27) 6 (32) 6 (30) 6 (22) 10. All other characters were within the variation found in Panama.

## Genus *Microcosmus* Heller, 1877

### *Microcosmus exasperatus* Heller, 1878

Fig. 4R

**Material examined.** CAGoM-0131, B10, 11 m, 17-06-2015, leg. L. Palomino-Alvarez; CAGoM-0048, Pro 1, 8 m, 26-05-2015, leg. L. Palomino-Alvarez; CAGoM-00476, Chp 1, 5 m, 26-05-2015, leg. L. Palomino-Alvarez; CAGoM-0731, Sis, 1 m, 21-03-2018, leg. L. Palomino-Alvarez.

**Remarks.** Can be very common on mangrove prop roots in the Caribbean Sea (Panama – Rocha el al. 2005, Venezuela – Rocha et al. 2010). Here we found it mainly in harbors, with > 20 specimens found in Sisal harbour, suggesting that it was introduced.

**Global distribution.** United States (Van Name 1921, 1945), Bermudas (Berrill 1932; Monniot 1972), Jamaica (Heller 1878; Goodbody 2003), Belize (Goodbody 2000), Panamá (Collin et al. 2005; Carman et al. 2011), Curaçao (Van Name 1924; Millar 1962; Goodbody 1984), Venezuela (Rocha et al. 2010; Carballo-Pérez and Díaz 2011), Tobago (Cole 2012), Martinique (Gravier 1955; Monniot 2018c), Antilles (Sluiter 1898; Van Name 1921, 1931), Guadeloupe (Monniot 1983), Brazil (Rodrigues 1962; Rodrigues et al. 1998; Monniot and Monniot 2001; Rocha et al. 2012; Rocha

and Costa 2005; Rocha and Kremer 2005; Rocha et al. 2005), Azores (Harant 1929), Cape Verde (Harant 1929), Mediterranean sea (Streftaris et al. 2005; Turon et al. 2007), Red Sea (Shenkar 2012), Philippine Sea (Van Name 1918), Mindoro (Tokioka 1970), Truuk Islands (Nishikawa 1984), Guam (Lambert 2003), Australia (Kott 1985; Monniot 1992).

### Family Molgulidae Lacaze-Duthiers, 1877
### Genus *Molgula* Forbes, 1848

#### *Molgula occidentalis* Traustedt, 1883

**Material examined.** CAGoM-0734, Sis, 1 m, 21-03-2018, leg. L. Palomino-Alvarez.

**Remarks.** The single specimen was found with *M. exasperatus* on a cement column.

**Global distribution.** Unites States (Van Name 1945), Panama (Collin et al., 2005; Rocha et al. 2005), Curaçao (Van Name 1924; Millar 1962; Goodbody 1984), Venezuela (Goodbody 1984; Rocha et al. 2010), Virgin Islands (Traustedt 1883), Puerto Rico (Van Name 1921, 1930), Brazil (Monniot 1970), Senegal (Pérès 1949; Monniot 1969; Lafargue and Wahl 1987; Monniot and Monniot 1994), Italy (Monniot 1970).

## Discussion

With this first checklist from the southern Gulf of Mexico, we list 31 species, five in the order Phlebobranchia, 19 Aplousobranchia and seven Stolidobranchia. Ascidians found in the southern Gulf of Mexico comprise 24% of the species, 24% of the genera and 60% of the families of ascidians that have been found throughout the Gulf of Mexico (Van Name 1945; Abbott 1951; Carballo 2000; Lambert et al. 2005; Cole and Lambert 2009). Also, they comprise 7% of the species, 22% of the genera and 53% of the families reported from the Atlantic Ocean (Rocha et al. 2012). Styelidae and Polycitoridae are the most species-rich families.

The number of species we found is surprisingly less than expected and that have been reported from other regions of the Caribbean, including Belize, Bocas del Toro (Panama), Jamaica and Guadeloupe, while similar to the number of species found in Cuba, Curaçao and Puerto Rico (Rocha et al., 2005). A possible explanation for fewer species is simply variation in sampling effort among studies, or that greater diversity has been found in association with mangrove roots in some of those studies. Mangroves are less common in the southern Gulf of Mexico surveyed here and therefore they were sampled less often in this study. In the present study we visited eight coral reefs, where ascidians are mainly found beneath pieces of dead coral and in crevices and pits where they are not easily found. Sampling effort was somewhat greater in the two sites with more species (Madagascar and Bajo 10). Four sites were in harbors or associated with marinas and urban construction, one of which had many species (Progreso). Harbors are known as entrances for exotic species, among which only *C. roseolus*, *P. constellatum*

**Table 3.** World distribution of the ascidian species found in the present survey in southern Gulf of Mexico.

| | Gulf N | Gulf S | Caribbean | West Atl | East Atl | Medit | Indian | Pacif |
|---|---|---|---|---|---|---|---|---|
| **Total #** | **19** | **31** | **25** | **21** | **16** | **9** | **10** | **10** |
| *Ascidia panamensis* | | x | x | | | | | |
| *Phallusia nigra* | x | x | x | x | x | x | x | |
| *Corella minuta* | x | x | x | | | | x | x |
| *Ecteinascidia styeloides* | | x | x | | | | x | |
| *Ecteinascidia turbinata* | x | x | x | x | x | x | | |
| *Clavelina oblonga* | x | x | x | x | x | x | | |
| *Clavelina* sp. | | x | | | | | | |
| *Cystodytes dellechiajei* | x | x | x | x | x | x | | x |
| *Cystodytes roseolus* | | x | | | x | | x | |
| *Eudistoma* aff. *amanitum* | | x | x | | | | | |
| *Eudistoma clarum* | x | x | x | | x | | | x |
| *Eudistoma hepaticum* | x | x | x | | | | | |
| *Eudistoma obscuratum* | x | x | x | x | | | | |
| *Eudistoma olivaceum* | x | x | x | x | x | | | x |
| *Eudistoma recifense* | | x | | x | | | | |
| *Stomozoa roseola* | x | x | | x | x | | x | x |
| *Distaplia bermudensis* | x | x | x | x | x | x | | |
| *Polysyncraton amethysteum* | x | x | x | x | x | x | | |
| *Lissoclinum fragile* | x | x | x | x | x | | x | x |
| *Didemnum duplicatum* | x | x | x | x | | | | |
| *Didemnum granulatum* | | x | x | x | x | | x | x |
| *Polyclinum constellatum* | x | x | x | x | x | | x | x |
| *Euherdmania fasciculata* | | x | x | x | | | | |
| *Euherdmania* aff. *vitrea* | | x | | x | | | | |
| *Polycarpa cartilaginea* | | x | x | | | | | |
| *Polycarpa spongiabilis* | x | x | x | x | | | | |
| *Botrylloides magnicoecus* | | x | | x | x | | | |
| *Botrylloides niger* | x | x | x | x | x | x | x | x |
| *Pyura* sp. | | x | x | | | | | |
| *Microcosmus exasperatus* | x | x | x | x | x | x | x | x |
| *Molgula occidentalis* | x | x | x | x | | x | | |

and *M. exasperatus* are likely to be introduced. Some species found in anthropogenic sites are widely distributed and have been introduced elsewhere (e.g., *D. perlucidum*, *L. fragile*, *E. turbinata*, *P. nigra* – Renganathan 1982; Monniot et al. 1985; Sheehy and Vik 2010; Thessalou et al. 2012; Vandepas et al. 2015).

Major affinities of the ascidian fauna in southern Gulf of Mexico are with the Caribbean Sea (25 shared species) and West Atlantic countries with tropical or warm waters (21 species), and only then with the northern region of the Gulf (19 species). Half of the species are also found in the east Atlantic region, and 13 species have wide geographical distribution including either or both Indian and Pacific oceans waters (Table 3). In contrast, we found a few species that are very common elsewhere in the Caribbean Sea, including *Rhopalaea abdominalis*, *Ascidia curvata*, *A. interrupta*, *Symplegma rubra*, *S. brakenhielmi*, *Pyura vittata*, and *Herdmania pallida*. Whether there are oceanographic or biological barriers preventing species from entering the southern

Gulf of Mexico remains to be tested. Also, increasing sampling effort will certainly uncover more species.

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## References

Abbott DP (1951) *Bostrichobranchus digonas*, a new molgulid ascidian from Florida. Journal of the Washington Academy of Sciences 41(9): 302–308.

Alvarez L, Simoes N, Rocha R (2018) Checklist of ascidians (Chordata: Tunicata) from south of the Gulf of Mexico. Zenodo. [Data set] http://doi.org/10.5281/zenodo.1478185

Bermudez IR, Grimaldi JR (1975) Estudio comparativo de cuatro especies de ascidias de la Bahia de Mochima, Edo, Sucre. Lagena 35–36: 31–49.

Berrill NJ (1932) Ascidians of the Bermudas. The Biological Bulletin 62: 77–88. https://doi.org/10.2307/1537145

Berrill NJ (1935) Studies in tunicate development. Part III. Differential retardation and acceleration. Philosophical Transactions of the Royal Society of London (B) 225(525): 255–326.

Berrill NJ (1950) The Tunicata. With an account of the British species. Ray Society, London, 354 pp.

Bonnet NYK, Rocha RM (2011a) The family Ascidiidae Herdman (Tunicata: Ascidiacea) in Bocas del Toro, Panama. Description of six new species. Zootaxa 2864: 1–33.

Bonnet NYK, Rocha RM (2011b) The Ascidiidae (Ascidiacea: Tunicata) of coastal Brazil. Zoological Studies 50(6): 809–825.

Brunetti R (1994) Ascidians of the northern Adriatic Sea. Aplousobranchia 1. Bollettino di Zoologia Italiana 61: 89–96. https://doi.org/10.1080/11250009409355864

Brunetti R (2010) Redescription of *Botrylloides magnicoecum* (Hartmeyer, 1912) based on the analysis of the type (Tunicata, Ascidiacea, Styelidae, Botryllinae). Bollettino del Museo civico di storia naturale di Venezia 61: 45–48.

Carballo JL (2000) Distribution of *Ecteinascidia turbinata* (Ascidiacea: Perophoridae) in mangroves of the Yucatan Peninsula, Mexico. Revista de Biología Tropical 48: 365–369.

Carballo-Pérez V, Díaz O (2011) Ascidians (Tunicata: Ascidiacea) of Cariaco Gulf, Venezuela. Boletín del Instituto Oceanográfico de Venezuela 50(2): 233–244.

Carman MR, Bullard SG, Rocha RM, Lambert G, Dijkstra JA, Roper JJ, Goodwin A, Carman MM, Vail EM (2011) Ascidians at the Pacific and Atlantic entrances to the Panama Canal. Aquatic Invasions 6: 371–380. https://doi.org/10.3391/ai.2011.6.4.02

Casso M, Navarro M, Ordóñez V, Fernández-Tejedor M, Pascual M, Turon X (2018) Seasonal patterns of settlement and growth of introduced and native ascidians in bivalve cultures in the Ebro Delta (NE Iberian Peninsula). Regional Studies in Marine Science 23: 12–22. https://doi.org/10.1016/j.rsma.2017.11.002

Cole LL, Lambert G (2009) Tunicata (Urochordata) of the Gulf of Mexico. In: Felder D, Camp DK (Eds) Gulf of Mexico – Origins, Waters, and Biota Biodiversity. Texas A and M Press, College Station, 1209–1216.

Cole LL (2012) Diversity and distribution of Tunicata (Urochordata) in Tobago. Journal of Life Sciences 6: 221–232.

Collin R, Díaz MC, Norenbur J, Rocha RM, Sanchez J, Schulze A, Schwartz M (2005) Photographic identification guide to some common marine invertebrates of Bocas del Toro. Caribbean Journal of Science 41(3): 638–707.

CONABIO (2016) Comisión Nacional para el Uso y conocimiento de la Biodiversidad. Sistema Nacional de Información sobre Biodiversidad de México (SNIB). http://www.conabio.gob.mx/remib/doctos/snib.html

Della Valle A (1877) Contribuzioni alla storia naturalle delle ascidie composte del Golfo di Napoli. Napoli, tip. Comuni, 48 pp.

Dias G, Rocha RM, Lotufo TMC, Kremer LP (2012) Fifty years of ascidian biodiversity research in São Sebastião, Brazil. Journal of the Marine Biological Association of the United Kingdom 93(1): 273–282.

Drasche R (1883) Die Synascidien der Bucht von Rovigno (Istrien). In: Ein Beitrag zur Fauna der Adria. Carl Gerolds Sohn, Wien, 41.

Draughon D, Scarpa J, Hartmann JX (2010) Are filtration rates for the rough tunicate *Styela plicata* independent of weight or size? Journal of Environmental Science and Health 45: 168–176.

Erba E, Bergamaschi D, Bassano L, Damia G, Ronzoni S, Faircloth GT, D'Incalci M (2001) Ecteinascidin-743 (ET-743), a natural marine compound, with a unique mechanism of action. European Journal of Cancer 37: 97–105. https://doi.org/10.1016/S0959-8049(00)00357-9

Fortaleza MTV, Lotufo TMC (2018) Polyclinidae (Ascidiacea: Aplousobranchia) from the Gulf of Mexico, collected during the "Hourglass" cruises (1965–1967). Zootaxa 4422: 519–536. https://doi.org/10.11646/zootaxa.4422.4.4

Ghobashy AFA, Abdel Messeih MK (1991) Ascidians in Egyptian waters. Journal of the Egyptian-German Society of Zoology 4: 313–326.

Goodbody I (1984a) Ascidians from Caribbean shallow water localities. Studies on the Fauna of Curaçao and other Caribbean Islands 47(203): 62–76.

Goodbody I (1984b) The ascidian fauna of two contrasting lagoons in the Netherland Antilles: Pescadera baai, Curaçao, and the lac of Bonaire. Studies on the Fauna of Curaçao and other Caribbean Islands 48(202): 21–61.

Goodbody I (1993) The ascidian fauna of a Jamaican lagoon: thirty years of change. Revista de Biología Tropical (Suppl.) 41(1): 35–38.

Goodbody I (2000) Diversity and distribution of ascidians (Tunicata) in the Pelican Cays, Belize. Atoll Research Bulletin 480: 1–33. https://doi.org/10.5479/si.00775630.480

Goodbody I (2003) The ascidian fauna of Port Royal, Jamaica 1. Harbor and mangrove dwelling species. Bulletin of Marine Science 73: 457–476.

Goodbody I (2004) Diversity and distribution of ascidians (Tunicata) at Twin Cays, Belize. Atoll Research Bulletin 524: 1–22. https://doi.org/10.5479/si.00775630.524.1

Goodbody I, Cole L (2006) The tropical western atlantic Perophoridae (Ascidiea) 11. The genus Ecteinascidia. Bulletin of Marine Science 79(1): 49–70.

Gravier R (1955) Ascidies recoltées par le 'President Theodore Tissier' (Campagne de printemps 1951). Révue des Travaux de l'Institut des Peches Maritimes 19(4): 611–631.

Harant H (1927) Introduction synoptique a une faune de France des tuniciers. 1. Ascidies Stolidobranchiates. Bulletin de l'Institut océanographique de Monaco 508: 1–10.

Harant H (1929) Ascidies provenant des croisières du Prince Albert Ier de Monaco. Résultats des Campagnes Scientifiques Monaco 75: 1–112.

Harant H, Vernières P (1933) Tuniciers. Fasc. 1, Ascidies. Faune de France 27: 1–101.

Hartmeyer R (1912) Die ascidien der Deutschen Tiefsee-Expedition. Deutschen Tiefsee-Exp 17: 223–392.

Heller C (1878) Beitrage zur nahern Kenntniss der Tunicaten. Sitzber. Denkschriften der Kaiserlichen Akademie der Wissenschaften 77(1): 2–28.

Herdman WA (1880) Preliminary report on the Tunicata of the Challenger expedition. Part 2. Proceedings of the Royal Society of Edinburgh 10(2): 714–726. https://doi.org/10.1017/S03701646000044606

Herdman WA (1882) Report on the Tunicata collected during the voyage of H.M.S. Challenger during the years 1873–1876, part 1, Ascidiae simplices. Rep. sci. Res. Voy. H.M.S. "Challenger". Zoology 6(17): 1–296.

Herdman WA (1886) Report on the Tunicata collected during the years 1873–1876. Part 2, Ascidiae compositae. Journal of Experimental Zoology 14(38): 1–425.

Hernández-Zanuy A (1990) Lista de ascidias cubanas. Poeyana 388: 1–7.

Hernández-Zanuy A, Carballo J (2001) Distribution and abundance of ascidian assemblages in Caribbean reef zones of the Golfo de Batabanó (Cuba). Coral Reefs 20: 159–162. https://doi.org/10.1007/s003380100154

Jeffery WR (2015) Closing the wounds: One hundred and twenty-five years of regenerative biology in the ascidians *Ciona intestinalis*. Genesis 53: 48–65. https://doi.org/10.1002/dvg.22799

Kondilatos G, Corsini-Foka M, Pancucci-Papadopoulou MA (2010) Occurrence of the first non-indigenous ascidian *Phallusia nigra* Savigny, 1816 (Tunicata: Ascidiacea) in Greek waters. Aquatic Invasions 5(2): 181–184. https://doi.org/10.3391/ai.2010.5.2.08

Kott P (1957) The sessile tunicata. The John Murray Expedition, 1933–1934, Scientific Reports 10(4): 129–149.

Kott P (1981) The ascidians of the Reef Flats of Fiji. Proceedings of the Linnean Society of New South Wales 105(3): 147–212.

Kott P (1985) The Australian Ascidiacea Part 1, Phlebobranchita and Stolidobranchita. Memoirs of the Queensland Museum 23: 1–440.

Kott P (1990) The Australian Ascidiacea, part 2, Aplousobranchia (1). Memoirs of the Queensland Museum 29(1): 1–226.

Kott P (2001) The australian Ascidiacea Part 4, Aplousobranchia (3), Didemnidae. Memoirs of the Queensland Museum 47(1): 1–407.

Kott P, Goodbody I (1982) The ascidians of Hong Kong. In: Morton BS, Tseng CK (Eds) The marine flora and fauna of Hong Kong and Southern China. University Press, Hong Kong, 503–554.

Lafargue F (1970) Ascidies de Port-Cros (Parc national). Annales de la Société des Sciences Naturelles de Toulon 22: 128–132.

Lafargue F, Vasseur P (1989) Ascidies des récifs coralliens du N. E. du canal de Mozambique (Campagne "Bentedi" du N. "Suroit", 17 mars – 14 avril 1977). Mésogée 49: 59–66.

Lafargue F, Wahl M (1987) Contribution to the knowledge of littoral ascidians (Ascidiacea, Tunicata) of the Senegalese coast. Bulletin de l'Institut Fondamental d'Afrique Noireser A 46(3–4): 385–402.

Lambert G (2003) Marine biodiversity of Guam: the Ascidiacea. Micronesica 35–36: 588–597.

Lambert G (2005) Ecology and natural history of the protochordates. Canadian Journal of Zoology 83: 34–50. https://doi.org/10.1139/z04-156

Lambert G, Faulkes Z, Lambert CC, Scofield VL (2005) Ascidians of South Padre Island, Texas, with a key to species. Texas Journal of Science 57: 251–262.

López-Legentil S, Turon X (2005) How do morphoytpes and chemotypes relate to genotypes? The colonial ascidian *Cystodytes* (Ascidiacea: Polycitoridae). Zoologica Scripta 34(1): 3–14. https://doi.org/10.1111/j.1463-6409.2005.00167.x

Mastrototaro F, Brunetti R (2006) The non-indigenous ascidian *Distaplia bermudensis* in the Mediterranean: comparison with the native species *Distaplia magnilarva* and *Distaplia lucillae* sp. nov. Journal of the Marine Biological Association of the United Kingdom 86: 181–185. https://doi.org/10.1017/S0025315406013014

Michaelsen W (1915) Tunicata. In: Beitrage zur Kenntnis der Meeresfauna westafrikas. Beitrge zur Kenntnis der Meeresfauna Westafrikas 1(3): 322–518.

Michaelsen W (1918) Die Ptychobranchen und Diktyobranchen Ascidien des westlichen Indischen Oceans. Jahrbuch der Hamburgischen Wissenschaftlichen Anstalten 35(2): 1–73.

Michaelsen W (1919) Die Krikobranchien Ascidien des Westlichen Indischen Ozeans: Claveliniden und Synoiciden. Mitteilungen aus dem Naturhistorischen Museum in Hamburg 34: 74–98.

Michaelsen W (1923) Südafricanische Ascidien. Meddelanden fran Göteborgs Musei Zoologiska avdelning 24: 1–23.

Michaelsen W (1930) Ascidiae Krikobranchiae. Fauna Sudvest-Australiensis 5: 461–558.

Michaelsen W (1934) The ascidians of the Cape Province of South Africa. Transactions of the Royal Society of South Africa 22: 129–163. https://doi.org/10.1080/00359193409519335

Millar RH (1953) On the collection of ascidians from the Gold Coast. Proceedings of the Zoological Society of London 123(2): 277–325. https://doi.org/10.1111/j.1096-3642.1953.tb00176.x

Millar RH (1955) On a collection of ascidians from South Africa. Proceedings of the Zoological Society of London 125(1): 169–221. https://doi.org/10.1111/j.1096-3642.1955.tb00597.x

Millar RH (1956) Notes on some ascidians from Sierra Leone and Gambia. The Annals and magazine of natural history 9(12): 409–417. https://doi.org/10.1080/00222935608655834

Millar RH (1958) Some ascidians from Brazil. The Annals and magazine of natural history 13(1): 497–514. https://doi.org/10.1080/00222935808650975

Millar RH (1961) *Euherdmania vitrea*, a new species of ascidian from Brazil. The Annals and magazine of natural history ser13, 4: 143–147. https://doi.org/10.1080/00222936108655793

Millar RH (1962a) Some ascidians from the Caribbean. Studies on the Fauna of Curaçao and other Caribbean Islands 13: 61–7.

Millar RH (1962b) Further descriptions of South African ascidians. Annals of the South African Museum 46(7): 113–221.

Millar RH (1965) Ascidians from the tropical coast of west Africa. Atlantide Reports 8: 247–255.

Millar RH (1968) Ascidian of Rabat Morocco. Bulletin de la Société des sciences naturelles du Maroc 47(1–2): 201–206.

Millar RH (1977) Ascidians (Tunicata: Ascidiacea) from the northern and north-eastern Brazilian shelf. The Annals and magazine of natural history 11(2): 169–223. https://doi.org/10.1080/00222937700770131

Millar RH (1988) Ascidians collected during the International Indian Ocean Expedition. The Annals and magazine of natural history 22: 823–848. https://doi.org/10.1080/00222938800770541

Monniot C (1969) Sur une collection d'ascidies de Dakar (Phlébobranches et Stolidobranches). Bulletin du Muséum National d'Histoire Naturelle 41(3): 622–654.

Monniot C (1970) Ascidies Phlébobranches et Stolidobranches des Iles Kerguelen recoltées par P. Grua. Bulletin du Muséum National d'Histoire Naturelle ser 2, 42(2): 340–354.

Monniot C (1971) Quelques ascidies infralittorales de Sao Miguel (Açores). Bulletin du Muséum National d'Histoire Naturelle ser 2, 42(6): 1200–1207.

Monniot C (1972a) Ascidies stolidobranches des Bermudes. Bulletin du Muséum National d'Histoire Naturelle ser 3, 43(57): 617–643.

Monniot C (1972b) Ascidies phlébobranches des Bermudes. Bulletin du Muséum National d'Histoire Naturelle ser 3, 6(82): 939–948.

Monniot C (1983a) Ascidies littorales de Guadeloupe. II. Phlébobranches. Bulletin du Muséum National d'Histoire Naturelle ser 4, sec A, 5(1): 51–71.

Monniot C (1983b) Ascidies littorales de Guadeloupe. IV. Styelidae. Bulletin du Muséum National d'Histoire Naturelle ser 4, sec A, 5(2): 423–456.

Monniot C (1987) Ascidies de Nouvelle-Calédonie. II. Les genres *Polycarpa* et *Polyandrocarpa*. Bulletin du Muséum National d'Histoire Naturelle ser 4, sec A, 9(2): 275–310.

Monniot C (1992) Ascidies de Nouvelle-Calédonie. XI. Phlébobranches et Stolidobranches du plateau des Chesterfield. Bulletin du Muséum National d'Histoire Naturelle ser 4, sec A, 14(1): 3–22.

Monniot C (1997) Ascidies phlébobranches du canal du Mozambique. Zoosystema 19(4): 557–571.

Monniot C, Monniot F (1967) Tuniciers benthiques. Campagne de la Calypso aux îles du Cap Vert (1959). Annales de l'Institut océanographique 45(2): 1–18.

Monniot C, Monniot F (1972) Clé mondiale des genres d'ascidies. Archives de zoologie expérimentale et générale 113(3): 311–367.

Monniot C, Monniot F (1987a) Les ascidies de Polynésie française. Mémoires du Muséum d'histoire naturelle, séc A, 136: 1–155.

Monniot C, Monniot F (1994) Additions to the inventory of eastern tropical Atlantic ascidians: arrival of cosmopolitan species. Bulletin of Marine Science 54(1): 71–93.

Monniot C, Monniot F (1997) Records of ascidians from Bahrain, Arabian Gulf with three new species. Journal of Natural History 31: 1623–1643. https://doi.org/10.1080/00222939700770871

Monniot C, Monniot F, Laboute P (1985) Ascidies du port de Papeete (Polynésie française): relations avec le milieu naturel et d'autres ports. Bulletin du Muséum National d'Histoire Naturelle ser 4, sec A, 7(3): 481–495.

Monniot C, Monniot F, Laboute P (1991) Coral reef ascidians of New Caledonia. Collection Faune tropicale, Editions de l'ORSTOM, Paris 30, 247 pp.

Monniot F (1969) Sur une collection d'ascidies composées de Dakar. Bulletin du Museum national d'histoire naturelles ser 2, 41(2): 426–247.

Monniot F (1972) Ascidies aplousobranches des Bermudes. Polyclinidae et Polycitoridae Bulletin du Muséum National d'Histoire Naturelle ser 3, 82(1): 949–962.

Monniot F (1983a) Ascidies littorales de Guadeloupe I. Didemnidae. Bulletin du Muséum National d'Histoire Naturelle ser 4, sec A, 5(1): 5–49.

Monniot F (1983b) Ascidies littorales de Guadeloupe III. Polyclinidae. Bulletin du Muséum National d'Histoire Naturelle ser 4, sec A, 5(2): 413–422.

Monniot F (1983c) Ascidies littorales de Guadeloupe V. Polycitoridae. Bulletin du Muséum National d'Histoire Naturelle ser 4, sec A, 5(4): 999–1019.

Monniot F (1988) Ascidies de Nouvelle Calédonie V. Polycitoridae du lagon. Bulletin du Muséum National d'Histoire Naturelle ser 4, sec A, (2): 197–235.

Monniot F (1992) Ascidies de Nouvelle Calédonie XII. Le genre *Lissoclinum* (Didemnidae) dans le lagon sud. Bulletin du Muséum National d'Histoire Naturelle ser 4, sec A, 14(3–4): 565–589.

Monniot F (1995) Ascidies de Nouvelle-Caledónie. XV. Le genre *Didemnum*. Bulletin du Muséum National d'Histoire Naturelle 4 ser, sec A, 16(2–4): 299–344.

Monniot F (2007) Some comments on the Ascidians of New Caledonia. In: Pyari CE, Rieher de Forges B (Eds) Compendium of marine species from New Caledonia. Documents Scientifiques et Techniques, EDITOR (117): 349–356.

Monniot F (2012) Some ascidians from the southern coast of Madagascar collected during the "AtimoVatae" survey. Zootaxa 3197: 1–42.

Monniot F (2016) Ascidians (Tunicata) of the French Guiana Expedition. Zootaxa 4114(3): 201–245. https://doi.org/10.11646/zootaxa.4114.3.1

Monniot F (2018a) Ascidians collected during the Madibenthos expedition in Martinique: 1. Phlebobranchia. Zootaxa 4387(3): 451–472. https://doi.org/10.11646/zootaxa.4387.3.3

Monniot F (2018b) Ascidians collected during the Madibenthos expedition in Martinique: 2. Stolidobranchia, Styelidae. Zootaxa 4410: 291–318. https://doi.org/10.11646/zootaxa.4410.2.3

Monniot F (2018c) Ascidians collected during the Madibenthos expedition in Martinique 3. Stolidobranchia, Pyuridae and Molgulidae. Zootaxa 4459: 401–430. https://doi.org/10.11646/zootaxa.4459.3.1

Monniot F, Monniot C (1996) New collections of ascidians from the Western Pacific and Southeastern Asia. Micronesica 29(2): 133–279.

Monniot F, Monniot C (2001) Ascidians from the tropical western Pacific. Zoosystema 23(2): 201–383.

Naranjo SA, García-Gómez JC (1994) Ascidia litorales del estrecho de Gibraltar: nuevas aportaciones faunísticas. Graellsi 50: 57–69.

Naranjo SA, Carballo JL, García-Gómez JC (1996) Effects of environmental stress on ascidian populations in Algeciras Bay (southern Spain). Possible marine bioindicators? Marine Ecology Progress Series 144: 119–131. https://doi.org/10.3354/meps144119

Nishikawa T (1984) Ascidians from the Trunk Island, Ponape Island and Majuro atoll (Tunicata: Ascidiacea). Proceedings of the Japanese Society of Systematic Zoology 27: 107–140.

Nishikawa T (1991) The ascidians of the Japan Sea 2. Publications of the Seto Marine Biological Laboratory 35 (1/3): 25–170. https://doi.org/10.5134/176172

Oliveira LM, Gamba GA, Rocha RM (2014) *Eudistoma* (Ascidiacea: Polycitoridae) from tropical Brazil. Zoologia 31(2): 195–208. https://doi.org/10.1590/S1984-46702014000200011

Ordóñez V, Pascual M, Fernández-Tejedor M, Turon X (2016) When invasion biology meets taxonomy: *Clavelina oblonga* (Ascidiacea) is an old invader in the Mediterranean Sea. Biological Invasions 18(4): 1203–1215. https://doi.org/10.1007/s10530-016-1062-0

Oren U, Benayahu Y (1998) Didemnid ascidians: rapid colonizers of artificial reefs in Eilat (Red Sea). Bulletin of Marine Science 63(1): 199–206.

Paiva SV, Rocha MR (2018) A large marine Caribbean mushroom field: description of *Eudistoma amanitum* sp.nov. (Ascidiacea: Polycitoridae). Zootaxa 4399(3): 443–450. https://doi.org/10.11646/zootaxa.4399.3.13

Paiva SV, Oliveira-Filho RR, Lotufo TMC (2015) Ascidians from Rocas Atoll, northeast Brazil. Frontiers in Marine Science 2: 39. https://doi.org/10.3389/fmars.2015.00039

Pérès JM (1949) Contribution a l'étude des Ascidies de la côte occidentale d'Afrique. Bulletin de l'Institut fondamental d'Afrique noire 11(1–2): 159–207.

Pérès JM (1951) Nouvelle contribution a l'étude des ascidies de la côte occidentale d'Afrique Bull Institut fondamental d'Afrique noire 13: 1051–1071.

Pérès JM (1958) Ascidies récoltées sur les côtes Méditerranéennes d'Israel. Bulletin of the Research Council of Israel (B Zool) 7(3–4): 143–150.

Petersen JK, Riisgard HU (1992) Filtration capacity of the ascidian *Ciona intestinalis* and its grazing impact in a shallow fjord. Marine Ecology Progress Series 88(1): 9–17. https://doi.org/10.3354/meps088009

Plough HH (1978) Sea Squirts of the Atlantic Continental Shelf from Maine to Texas. Johns Hopkins Univ. Press, Baltimore, 118 pp.

Renganathan TK (1982) On the occurrence of a colonial ascidian *Lissoclinum fragile* (Van Name, 1902) from India. Current Science 51(3): 149.

Ramos A, Buencuerpo V, Vazquez E, Lafarque F (1993) Distribución bionómica de las ascidias litorales del Estrecho de Gibraltar. Publicación Especial del Instituto Español de Oceanografía 11: 2–36.

Ríos M (1985) Ascidias (Ascidiacea, Tunicata) de la isla de Fuerteventura. Vieraea 15(1–2): 123–138.

Rocha RM, Bonnet NYK (2009) Ascídias (Tunicata, Ascidiacea) introduzidas no Arquipélago de Alcatrazes, São Paulo. Iheringia, Série Zoologia 99(1): 27–35. https://doi.org/10.1590/S0073-47212009000100004

Rocha RM, Costa LVG (2005) Ascidians (Urochordata: Ascidiacea) from Arraial do Cabo, Rio de Janeiro, Brazil. Iheringia, Série Zoologia 95(1): 57–64. https://doi.org/10.1590/S0073-47212005000100009

Rocha RM, Faria SB (2005) Ascidians at Currais Islands, Paraná, Brazil: taxonomy and distribution. Biota Neotropica 5(2): 1–20. https://doi.org/10.1590/S1676-06032005000300013

Rocha RM, Kremer LP (2005) Introduced Ascidians in Paranaguá Bay, Paraná, Southern Brazil. Revista Brasileira de Zoologia 22(4): 1170–1184. https://doi.org/10.1590/S0101-81752005000400052

Rocha RM, Bonnet NYK, Baptista MS, Beltramin FS (2012) Introduced and native Phlebobranch and Stolidobranch solitary ascidians (Tunicata: Ascidiacea) around Salvador, Bahia, Brazil. Zoologia 29(1): 39–53. https://doi.org/10.1590/S1984-46702012000100005

Rocha RM, Farias SB, Moreno TR (2005) Ascidians from Bocas del Toro, Panamá. I Biodiversity. Caribbean Journal of Science 41: 600–612.

Rocha RM, Guerra-Castro E, Lira C, Pauls SM, Hernandez I, Pérez A, Sardi A, Pérez J, Herrera C, Carbonini AK, Caraballo V, Salazar D, Diaz MC, Cruz-Motta JJ (2010) Inventory of ascidians (Tunicata, Ascidiacea) from the National Park La Restinga, Isla Margarita, Venezuela. Biota Neotropica 10(1): 1–10. https://doi.org/10.1590/S1676-06032010000100021

Rocha RM, Moreno TR, Metri R (2005) Ascídias (Tunicata, Ascidiacea) da Reserva Biológica Marinha do Arvoredo, Santa Catarina, Brasil. Revista Brasileira de Zoologia 22(2): 461–476. https://doi.org/10.1590/S0101-81752005000200024

Rocha RM, Zanata TB, Moreno TR (2012) Keys for identification of families and genera of Atlantic shallow water ascidians. Biota Neotropica 12(1): 1–35. https://doi.org/10.1590/S1676-06032012000100022

Rodrigues SA (1962) Algumas ascídias do litoral sul do Brasil. Boletim da Faculdade de Filosofia, Ciências e Letras, Universidade de São Paulo, ser Zool 24:193–215. https://doi.org/10.11606/issn.2526-3382.bffclzoologia.1962.120585

Rodrigues SA, Rocha RM (1993) Littoral compound ascidians (Tunicata) from São Sebastião, Estado de São Paulo, Brazil. The Proceedings of the Biological Society of Washington 106(4): 728–739.

Savigny JC (1816) Mémoires sur les animaux sans vertèbres. Paris 2: 1–239.

Sheehy DJ, Vik SF (2010) The role of constructed reefs in non-indigenous species introductions and range expansions. Ecological Engineering 36: 1–11. https://doi.org/10.1016/j.ecoleng.2009.09.012

Sheets EA, Cohen CS, Ruis, GM, Rocha RM (2016) Investigating the widespread introduction of a tropical marine fouling species. Ecology and Evolution 6(8): 2453–2471. https://doi.org/10.1002/ece3.2065

Shenkar N (2012) Ascidian (Chordata, Ascidiacea) diversity in the Red Sea. Marine Biodiversity Records 42(4): 459–469. https://doi.org/10.1007/s12526-012-0124-5

Shenkar N, Swalla BJ (2011) Global Diversity of Ascidiacea. PLoS ONE 6(6):e20657. https://doi.org/10.1371/journal.pone.0020657

Skinner LF, Rocha RM, Counts BK (2019) *Pyura gangelion* and *Pyura beta* sp. nov. (Ascidiacea: Pyuridae): an exotic and a new tunicate from the West Atlantic. Zootaxa (in press). https://doi.org/10.11646/zootaxa.4545.2.6

Sluiter CP (1898) Tuniciers recueilli en 1896, par la Chazalie, dans la mer des Antilles. Mémoires de la Société zoologique de France 11: 5–34.

Streftaris N, Zenetos A, Papathanassiou E (2005) Globalisation in marine ecosystems: the story of non-indigenous marine species across European seas. Oceanography and Marine Biology Annual Review 43: 419–453.

Thessalou-Legaki M, Aydogan O, Bekas P, Bilge G, Boyaci Y, Brunelli E, Circosta V, Crocetta F, Durucan F, Erdem M, Ergolavou A, Filiz H, Fois F, Gouva E, Kapiris K, Katsanevakis S, Kljajic Z, Konstantinidis E, Konstantinou G, Koutsogiannopoulos D, Lamon S, Macic V, Mazzette R, Meloni D, Mureddu A, Paschos I, Perdikaris C, Piras F, Poursanidis D, Ramos-Espla A, Rosso A, Sordino P, Sperone E, Sterioti A, Taskin E, Toscano F, Tripepi S, Tsiakkiros L, Zenetos A (2012) New Mediterranean Biodiversity Records. Mediterranean Marine Science 13(2): 312–327. https://doi.org/10.12681/mms.313

Tokioka T (1954) Contribution to japanese ascidian fauna. 7. Invertebrate fauna of the intertidal zone of the Tokara Islands. Ascidians. Publications of the Seto Marine Biological Laboratory 3(3): 239–264. https://doi.org/10.5134/174491

Tokioka T (1963) Contributions to Japanese ascidian fauna. XX. The outline of japanese ascidian fauna as compared with that of the Pacific coast of North America. Publications of the Seto Marine Biological Laboratory 11(1): 131–156. https://doi.org/10.5134/175319

Tokioka T (1967) Pacific Tunicata of the United States National Museum. Bulletin (United States National Museum) 251: 1–247. https://doi.org/10.5479/si.03629236.251.1

Tokioka T (1970) Ascidians from Mindoro Island, the Philippines. Publications of the Seto Marine Biological Laboratory 18(2): 75–107. https://doi.org/10.5134/175626

Tokioka T (1972) On a small collection of ascidians from the Pacific coast of Costa Rica. Publications of the Seto Marine Biological Laboratory 19(6): 383–408. https://doi.org/10.5134/175738

Tokioka T, Nishikawa T (1975) Contributions to the Japanese ascidian fauna XXVII. Some ascidians from Okinawa, with notes ona small collection from Hong Kong. Publications of the Seto Marine Biological Laboratory 22(5): 323–341.

Traustedt MPA (1882) Vestindiske Ascidiae Simplices, Forsie Afdeling. Phallusiadae. Videnskabelige meddelser fra Dansk Naturhistorisk Forening, ann 1881: 257–288.

Traustedt MPA (1883) Vestindiske Ascidiae Simplices, Anden Afdeling. Molgulidae og Cynthiadae. Videnskabelige meddelser fra Dansk Naturhistorisk Forening, ann 1882: 108–136. https://doi.org/10.1016/j.jembe.2006.10.040

Turon X, Nishikawa T, Rius M (2007) Spread of *Microcosmus squamiger* (Ascidiacea: Pyuridae) in the Mediterranean Sea and adjacent waters. Journal of experimental Marine Biology and Ecology 342(1): 185–188. https://doi.org/10.1016/J.JEMBE.2006.10.040

Vandepas LE, Oliveira LM, Lee SSC, Hirose E, Rocha RM, Swalla BJ (2015) Biogeography of *Phallusia nigra*: Is it really black and white? The Biological Bulletin 228: 52–64. https://doi.org/10.1086/BBLv228n1p52

Van Name WG (1902) The ascidians of the Bermuda Islands. Transactions of the Connecticut Academy of Arts and Sciences 11: 325–412.

Van Name WG (1918) Ascidians from the Philippines and adjacent waters. Bulletin of the American Museum of Natural History 100(1): 49–174.

Van Name WG (1921) Ascidians of the West Indian region and southeastern United States. Bulletin of the American Museum of Natural History 44: 283–494.

Van Name WG (1924) Ascidians from Curaçao. Bijdragen Tot de Dierkunde 23: 23–32.

Van Name WG (1930) The ascidians of Porto Rico and the Virgin Islands. Transactions of the New York Academy of Sciences 10: 401–512.

Van Name WG (1945) The North and South American ascidians. Bulletin of the American Museum of Natural History 84: 1–476.

Van der Sloot CJ (1969) Ascidians of the family Styelidae from the Caribbean. Studies on the Fauna of Curaçao and other Caribbean Islands 30: 1–57.

Vasseur P (1970) Contribution à l'étude des Ascidies de Madagascar (région de Tuléar). III. La faune ascidiologique des herbiers à phanérogames marines. Recueil des Travaux de la Station marine d'Endoume, Fasc hors serie suppl 10: 209–221.

Verrill AE (1900) Addition to the Tunicata and Molluscoidea of the Bermudas. Transactions of the Connecticut Academy of Arts and Sciences 10(2): 588–594. https://doi.org/10.5962/bhl.part.7034